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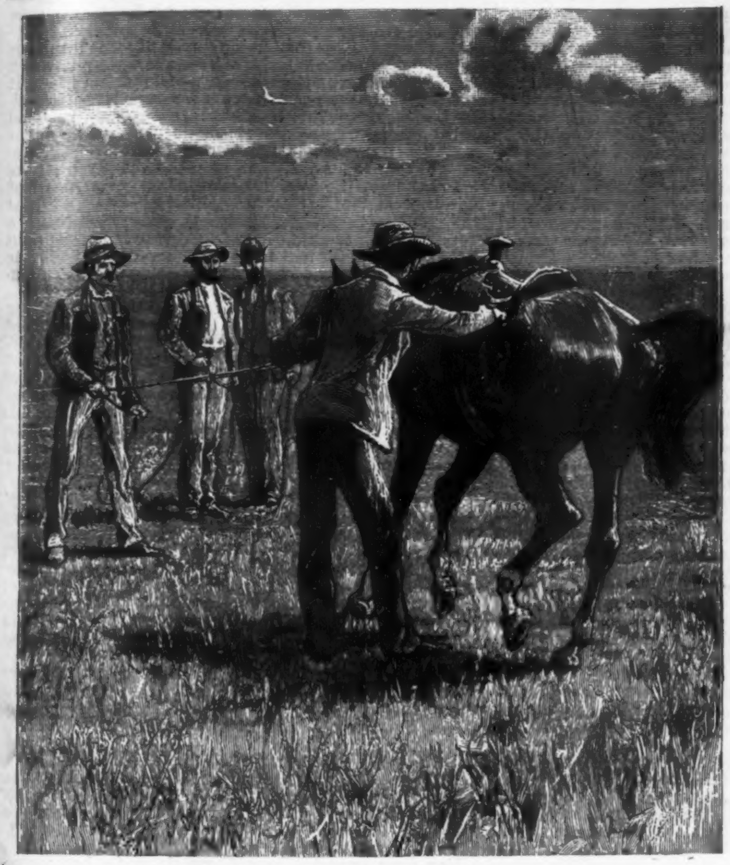

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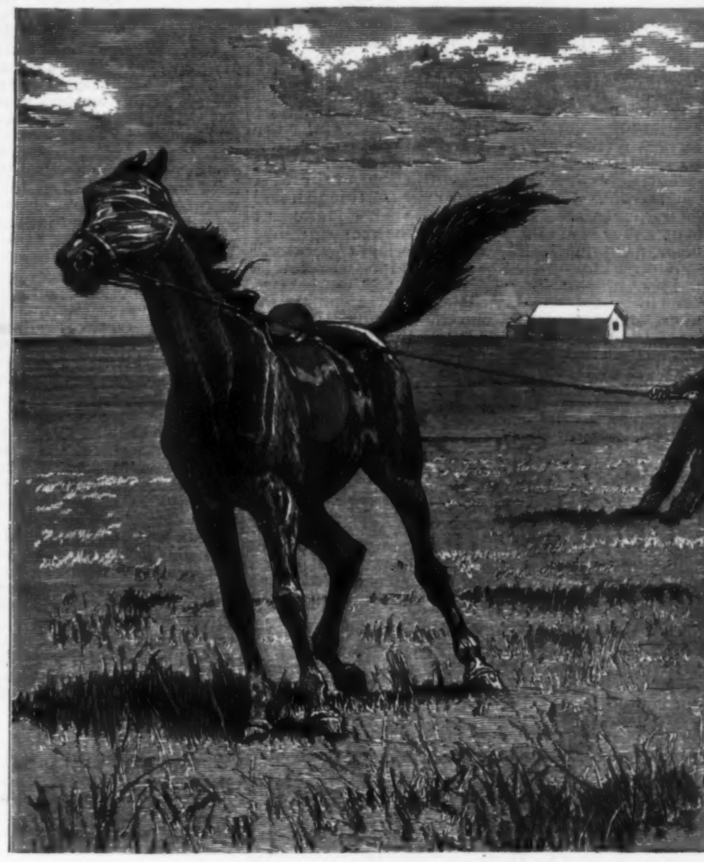

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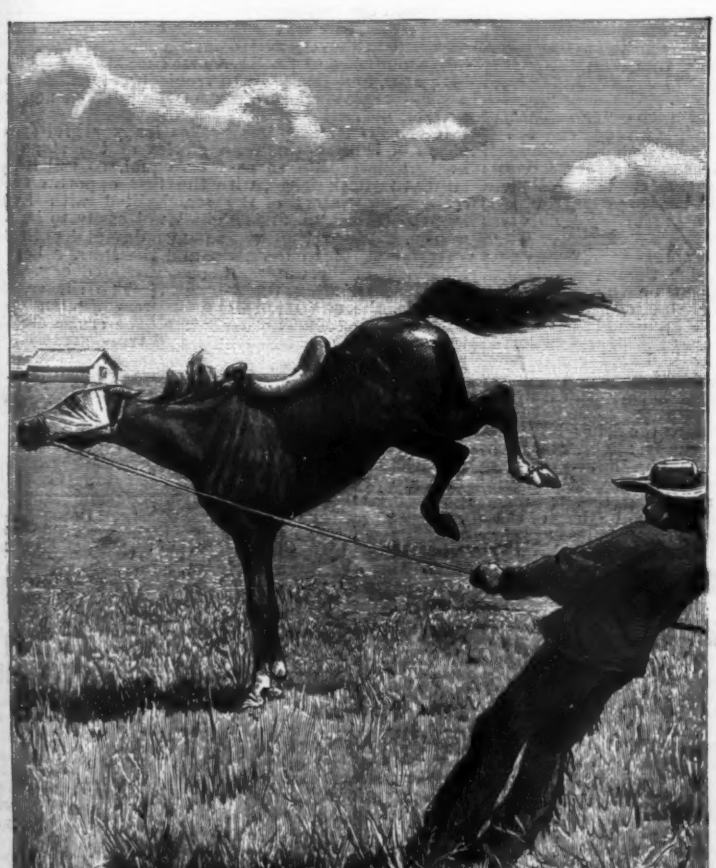


A FRUITLESS ATTEMPT TO THROW OFF THE YOKE.

A NOVEL SENSATION.

HORSE RANCHING IN QUEENSLAND—BREAKING IN WARRIGALS (WILD HORSES).

[Continued from SUPPLEMENT, No. 1038, page 16596.]

LUMINOUS ANIMALS.

By THOMAS R. R. STEBBING.

FIGUIER remarks that the phosphorescence of the sea, though observable throughout the ocean world, is most frequently seen in the Indian Ocean, the Arabian Gulf, and other tropical seas. He refers to the experience of Captain Kingman, who, in the American ship Shooting Star, traversed a zone of the Indian Ocean twenty-three miles in length so filled with phosphorescent animalcules that at night the water presented the appearance of a vast field of snow, and the "Milky Way" of the heavens was quite put out of countenance. Similarly we read that in 1616 the expedition to the East Indies under Martin Pring, when in the tropical Pacific, had one night what was to the members of that expedition a very mystifying spectacle. They beheld the sea all about them pale and white, resembling a vast cheese vat, so that one might have imagined "the ship to have been sailing in whey instead of salt water, it carried such a milky appearance along with it. The air and skie at the same time look'd white and hazy, without doubt the effect of the reflections from the surface of the water so dispos'd and color'd." In February, 1881, Mr. Daniel Pidgeon, a very acute observer, witnessed the phenomenon of this "Milky Sea" of the Pacific, when, he says, "the whole ocean from the ship to the visible horizon looked exactly as if it were covered with snow." "The snowy surface evidently reflected the light of the sky, for Venus, being very bright, threw a distinguishable line of radiance across it, while the phosphorescent crests of waves were now and then seen breaking above the layer of shining matter which overlaid the water." He convinced himself that the appearance was due to a thin layer of mist, produced when the sea surface happens to be considerably cooler than the moist atmosphere above it, so that the air in immediate contact with the water is chilled below the dew point and becomes misty, while the air above remains transparent.* It would be interesting to know whether the same explanation will apply to all displays of the "Milky Sea," or whether the effect should sometimes be attributed solely to phosphorescent animals and plants, and if not, whether in any case those sources of light contribute to illuminate the mist from below. Another eminently skilled observer, Dr. John Murray, reports that in August, 1880, he saw "at night on the surface of the sea in the Faroe Channel large patches and long streaks of apparently milky white water. The tow nets caught in these immense numbers of Nyctiphanes (Thysanopoda) norvegica, M. Sars, and the peculiar appearance of the water seemed to be due to the diffused light emitted from the phosphorescent organs of the species."

Though the shrimp just referred to bears no proportion in the size of the individuals to the length of its scientific designation, yet its numbers are so enormous that they provide food to fatten vast shoals of herrings for our contentment. Its generic name is significant of one that shines by night, and the family to which it belongs is called the Euphausiidæ, to indicate their fair effulgence. Many of these carry luminous globules symmetrically arranged on various parts of the body. In the living animal these are conspicuous in daylight by reason of their beautiful red pigment and lustrous appearance. At one time they were supposed to be accessory eyes, as though the wish which Milton imputes to Samson had here been granted, and nature had allowed these little shrimps to have sight, "as feeling, through all parts diffus'd, that she might look at will through every pore." But that the function of these globules is to contribute light, not sight, has now been all but demonstrated by Prof. G. O. Sars. Indeed, as these shrimps are provided with eyes on movable stalks, a very convenient arrangement for looking around, there would seem to be little necessity for them to have eyes also dotted about all over the body. By such an arrangement, they would only too often, like Cassandra, have been forced to foresee dangers which they had no means of avoiding. Those shrimps which have luminous organs in their jaws can scarcely be suspected of using them as accessory eyes. The lateral globules can be rolled about so as to direct flashes of light at the convenience of the animal, but in addition to these there are often a pair of immobile organs coated with red pigment and containing a bunch of phosphorescent fibers. These are planted on the stalks of the eyes, which are thus provided with natural lanterns.

It has been noticed by De Quatrefages and others that the shrimps known as sand hoppers become luminous, as almost any object may, by contact with phosphorescent sea water. But in 1889 Prof. Giard, at Wimereux, discovered a sand hopper that was luminous from within, not from without. He ascertained that in this case the phosphorescence was due to bacteria with which the creature's tissues were infested. From his single sand hopper he inoculated many others and spread the infection to various species in several genera of Crustaceans. They produced a fairy-like illumination of his laboratory at night time. Living specimens of the sand hopper wrapped in sea weed crossed the Channel in safety and showed their pale green light in an inland English town. Crustacea, however, of this same group sometimes no doubt have a radiance of their own. In especial, in the large-eyed division, the phosphoric light has been observed to stream out from the large eyes, as well as from some other parts of the body. The lighting up of the eyes themselves, whether in shrimps or crabs, does not seem very convenient for the purposes of vision. There may be some special accommodation to the circumstances or vision may not, in fact, be in question. It is possibly one of the innumerable instances of protective mimicry. The large gleaming eyes, perhaps, would fain be mistaken for a stinging medusa or any other occupant of the ocean which is recognized by the feeding community as bright but objectionable.

Higher in grade than the Crustacea are the Salpæ, which, by their living chains, produce a serpentine gleam in the water. Kindred with these is the Pyrosoma, to which reference has been already made. It is finely and fitly named "a body of fire." Every one has heard of the common ascidian or sea squirt, an unattractive object in its gray tunic of a tough leathery consistence. Very different in appearance from this and yet nearly related to it, is the Pyrosoma. Its structure was well fitted to puzzle the earliest observers, and succeeded in doing so. Of a specimen taken by the Challenger, Lord George Campbell gives in few words a very effective description. He makes a note in his log for the 25th of May, 1873:

"Trawled in 2,200 fathoms on very hard ooze ground an enormous 'pyrosoma' 4 ft. 2 in. long by 9 in. broad; it is a large sack closed at one end, and the whole spotted with pink lumps, each lump being a separate animal, in this case numbering one or two hundred thousand. . . . We imagine this pyrosoma must be the largest ever seen. At night as it lay in the tub it was most brilliantly phosphorescent, and we wrote upon it our names at full length, which presently came out in letters of brilliant light. An electric shock appeared to have no effect whatever on its nervous system."

But on the 26th he writes:

"The electric shock did, after all, affect the pyrosoma's nervous system, for in the night it fell into thousands of little gelatinous lumps, each with a pink nucleus, each being a separate animal."

There seems to be here some disregard of the logical dictum, post hoc, non ergo propter hoc. It has been found that in general these soft-bodied marine animals submit to an electrical experiment with indifference; but when it comes to signing blank checks upon their incorporated society, disintegration may well follow as a measure of common prudence. Fresh water poured on these animals has the singular effect of making the light steady instead of intermittent. By this means it was discovered that each individual in a Pyrosoma colony has two luminous organs, the parts which were at one time supposed to be ovaries. There is a social muscular system uniting the whole society, which helps to explain how a family of a hundred thousand can move together as if actuated by a single will, and how it is that when one member is excited to light up its little lanterns, the excitement gradually spreads till it produces an illumination of the whole household.

Among the vertebrates, until recently, the light-giving faculty was supposed to be extremely rare. The phosphorescence, indeed, of dead fishes is a matter of common observation, but this is attributable not to the fishes themselves, but to the presence of Bacterium phosphorescens, a little infusorian which very likely plays a large part in the diffused luminosity of the sea. In connection with captured fish its appearance is not at all to be dreaded, but the reverse, for as soon as the tissues of the fish begin to putrefy, the light of this bacterium is quenched. But independently of any extraneous organism, a large number of fishes in different families are now known to be luminous. The Latin names of the genera might scare an uninitiated reader. When done into English, however, such names as the Silver Ax, the Light Fish, the Many Lamps, the Lantern Eye, the Starry Swimmer, are pleasingly poetical as well as truthfully significant. The title of the Bombay Duck is less romantic. Imported as an article of food and known in England only in the dried state, this fish when first drawn from the water is brilliant with phosporescent mucus. A gleaming dog fish is known in the Pacific. On board the Challenger Dr. Von Willemoes Suhm saw a fish of the genus Scopelus which was brought up in the trawl at night shining like a star in the net. Nor should the experience of the ingenious young Frenchman, Adanson, be forgotten, though his voyage to Senegal was made in the middle of the last century. He forgave the pernicious white ants for repeatedly scaring him out of his slumbers for the sake of the observations and experiments on luminous animals which he was thus induced to make.

"My room," he says, "was full of pails of sea water, where I constantly kept live fish, which in the night time emitted a light not unlike that of phosphorus. The mugs full of shells, and even the fish that lay dead on the table, gave the same light. All these illuminations put together and reflected upon different parts of the room made it appear as if it was on fire. . . . What was most engaging, each fish showed itself plainly to the eye by the light emitted from its body; and the same effect was produced by the shells and other sea bodies which I had with me; even the pails themselves looked like a burning surface. This was not all. Every day the sight was new, because I had new fishes and new shells to observe. Now it was a pilchard, now a mole bat; one time a purple fish, another time a periwinkle; one time a polypus, a crab or a starfish, that showed its luminous rays in the dark. In short, I perfectly distinguished the shape of all those different fishes by rays of light which darted from every part of their bodies, and as I could place them in a thousand different positions, I had it in my power to give an infinite variety to this beautiful illumination."

In numerous instances in which the fishes have not been seen with their lamps actually alight, the existence in them of photogenic—that is, light-producing—organs has been placed beyond all reasonable doubt by the researches of Leuckart, Leydig, Ussow, Emery, Günther and others. From a special study of these organs, Dr. R. von Lendenfeld concludes that they are more or less modified glands, which have been developed partly from simple slime glands in the skin and partly in connection with the slime canal system. In very lowly organisms, in which the ordinary slime produced by the gland cells is luminous, the light is supposed to issue independently of the will of the animal. In higher groups a fatty substance secreted by glandular cells is, so to speak, burned under the influence of nervous stimulation, and therefore unless some appeal is made to the animal's nerves the light is held in reserve.

The fact that in fishes as well as in Crustaceans the phosphorescent organs have frequently been taken for actual eyes shows that their primitive simplicity has in many cases given place to a complicated development. Here be lenses and pigment layers and bundles of phosphorescent fibers and constrictive muscles and extensible membranes and other special matters chiefly interesting to the special student. The number of the organs is far from being in all fishes equal, nor is the disposition of them in all fishes alike. There may be but a single pair, or there may be dozens of pairs, or the luminous spots may be sprinkled over the body in an indefinite number.

In some species there are long lines of the eye-mimicking bead-like organs running along the sides of the fish in a manner that argues strongly for their development from the muciferous system. These long lateral lines of light perhaps produce the most brilliant effect in the abysses of the sea, but the organs occur in other positions that are more singular. In one strange little fish they appear to have ousted the eyes altogether. In various species they are found on the lower jaw, under the gill covers, on the barbels or close to the eyes. In rare instances the back behind the dorsal fin carries one or a few of these illuminators pointing backward.

In regard to the use of these "stern chasers" we are invited to imagine a race for life and death in the deep, dark waters. The greedy foe is just about to pounce, when, oh, what a surprise! he is suddenly dazzled and disconcerted by the flashing of a mysterious light in the very spot where he was expecting to grab the tail of a solid fish. Before he has done rubbing his eyes and vainly searching for any mode of expostulatory expression adequate to his disappointment, the "pilchard" has put out his light and gone away.

No space is left for doing justice to the luminous animals of the land, such as the glow worms, which are not worms, and the fireflies, which are not flies. It matters the less, since all men know how these beautiful beetles lend themselves to the poet in England and to the traveler in the tropics, and how they light up the cottage of the poor Indian and adorn the costume of fair Orientals. It can but barely be mentioned that we have a luminous centipede in Great Britain, and that in Sierra Leone there is, or at least was reported in 1607, a strange beast which "has a stone of an incredible luster in his forehead, so bright that he is not only thereby rendered visible in the darkest night, but sees also by the help of that natural torch to find out and manage his provender."

As long ago as 1818, G. R. Treviranus, after passing in review all the learning of his predecessors in regard to luminous animals, concludes that the light is derived from a special and in general specially localized substance. So far he was in agreement with the most modern researches. He considers that the substance has all the properties of a true phosphorus, and is only hindered from being burned up by its union with other animal materials. At a later date Matteucci has affirmed that the phosphorescent particles of the glow worm contain no phosphorus.

In various animals the luminosity no doubt has various functions, though we may assume that in every case it acts for the benefit of the species which possesses it. In some it may serve the common object of lamps to light up the darkness; in some it may be like the beacon of a lighthouse, to give warning of danger; in some, like the wrecker's treacherous signal, it may lure the wanderer to his doom; and in some it may be like the torch which Hero kindled in her tower to guide Leander through the waves.

In the dark recesses of the ocean it must be rather difficult to decide whether any particular lamp means "danger" or is a trustworthy invitation to come on. Under these complicated conditions of existence, it is not very surprising that some of the abyssal species have developed exceptionally large eyes in the endeavor to see what they are about, while others have by preference gone totally blind, so as to avoid a continual nervous strain and the necessity of a sudden decision in critical cases, which is so fatal to peace of mind and good digestion.

For very grand effects of seashine, to become acquainted with strange crustaceans luminous and alive, and to see "the sparkles which flash from their eyes," to behold the trailing clouds of glory in the wake of a great vessel, to view the foaming billows of an angry ocean when they seem "to metamorphose themselves into mountains of fire," recourse should be had to the high seas, and especially to tropical waters. Yet on a smaller scale the beauty of the phenomenon can be seen nearer home.

If the first pantomime evokes for youthful eyes a vision of delight which no glories of the stage beheld in later life surpass or equal, so will it be, either in youth or age, with the first opportunity of seeing the waters of the sea lighted with living lamps. It is "a first night" not easily to be forgotten. When the long summer day at length has left the world to darkness and the stars, a boat is launched on the waters of some sheltered bay. The winds are holding their breath. The silence, the solitude, the unwonted hour, impress the landsman with a feeling that the crew and the cruise are the instruments of an uncommon and truly great enterprise.

Presently the dipping of the oars calls forth here and there a sparkle in the water. The tow net is lowered. Hand nets are swished along at the sides of the boat. With every movement brilliant gems give forth innumerable flashes as far down as any disturbance of the water can be caused. When the nets are drawn up and inverted, they appear to be glistening everywhere with diamonds and pale emeralds, an entrancing sight, which seems almost like a dream when the specimens which produced it are seen the next morning, and the vision splendid has faded into the light of common day.

It may seem a piece of idleness to take pleasure in observing, and in hearing and talking about, the different parts of nature without an attempt to draw from them any lessons either of material advantage or of moral wisdom. But man is made like that, a creature of curiosity, and of the genus "man" the species "naturalist" is ever bound to behave like those brethren of Solomon's House in the "New Atlantis," who evidently think their own conduct something rather superior, when they calmly and sweetly say of themselves: "Thus you see we maintain a trade, not for gold, silver or jewels; nor for silks; nor for spices; nor for any other commodity of matter, but only for God's first creature, which was light—to have light, I say, of the growth of all parts of the world."—Blackwood's Magazine.

* An Engineer's Holiday, chap. xxii.

THE largest telegraph office in the world is in the general postoffice building, London. There are over three thousand operators, one thousand of whom are women. The batteries are supplied by thirty thousand cells.

[FROM THE BOSTON COMMONWEALTH.]

THE VOLCANOES OF HAWAII.

By EDWARD EVERETT.

I. THE ASCENT OF KILAUEA.

ON February 24, 1890, a party left Honolulu on the steamer W. G. Hall to make the volcano excursion. This boat pursued the southern or leeward route, and landed us at Punaluu, on the southeast side of the island of Hawaii, about 6 P. M. next day. We were rowed ashore through a foaming sea, to a landing in a nook between jagged rocks over which the sea was wildly dashing. A nice hotel provided us with a good supper and lodging.

Some apology is necessary for here offering an account of an excursion which was made five years ago, at an unfavorable time as regards the state of activity of the volcano, and on which I saw far less than is usually seen by visitors to the crater of Kilauea. Unfortunately at the time of my visit the crater was in its least active state, and the great fiery lake of Halema'uma'u was said to be out of business for the time, or as otherwise expressed "the bottom had fallen out." Owing to the continual changes in the condition of the volcano, every successive observer sees some different manifestation of its forces. The visitor on viewing for the first time these wonderful displays is dazzled and confused by what he sees, and it is only by much subsequent study and reflection that he can in part comprehend the phenomena underlying the action he witnesses.

But what I saw of Kilauea and afterward of the great extinct volcano of Haleakala on the island of Maui stimulated my desire to learn more, and has induced some speculation as to peculiar features and the causes of the phenomena exhibited. Having myself realized, on the excursion herein described, the need of explanatory information, which is only to be obtained by prolonged investigation or by attentive perusal of voluminous scientific works, I add to my narrative of the trip, without pretending to any complete elucidation, some important facts, gathered from the works of Dana, Brigham, Judd and others, together with some remarks which have suggested themselves to my mind.

The following morning after breakfast we left by a narrow (2 foot) gage railway, on our way up the mountain. This took us about 6 miles to a large sugar plantation, for the use of which the road was built over a rough and broken field of lava. Here we were transferred to carriages, one drawn by 6 horses and the other by 4 mules. We had a comfortable journey up the gentle ascent of the mountain 23 miles to the Volcano House, at an elevation above the sea of 4,040 feet. There was no abrupt ascent, and little noticeable steepness, except in uneven places, and when up, there was no appearance of excessive height, except that the temperature was much cooler.

The way was over lava fields in a more or less decomposed state, some having been converted by age and the elements into rich soils, with luxuriant vegetation on them, while other and fresher flows showed little sign of wear since their rough surfaces and upheaved masses were left to cool. In tracts where wild grasses and various vegetation had taken possession, tame and wild cattle find a living, but a precarious one, for in dry times they starve, and suffer for want of water. For the character of the lava flow is such that large caves and channels are formed by the cooling of a firm crust on the surfaces, while the hot lava flows on below, leaving arched sewers which conduct the rainfall to the sea, wholly underground. Near the crater the vegetation increased in beauty and abundance.

We arrived at the Volcano House between 4 and 5 P. M. The approach to it was near the brink of the crater, and between it and huge sulphur beds emitting dense vapor, which, added to that proceeding from numerous steam cracks in the vicinity, rendered the atmosphere of the neighborhood exceedingly damp. Some of the party went across the crater to the burning lake after our arrival, and returned about 11 P. M.

The majority of the party waited till the next day, and at 3 P. M. descended into the enormous crater of Kilauea, which may be described as a long irregular oval, the floor of which has apparently sunk to its present level, at a depth of 500 to 600 ft. below the edges, which are in general vertical walls or cliffs. The dimensions are 3 to 4 miles long and 2 to 3 miles wide, with a circumference of 9 miles, more or less. The descent was by a winding path on rocks which had fallen away from the side of the precipice. The distance from the hotel to Dana Lake, at that time the only active part of the volcano, was stated to be 3½ miles, and we judged it was not overstated. The descent to the floor of the crater was counted as one mile, and the path was easy, that is going down, and was flanked by luxurious vegetation, tree ferns, ohias, sword grass, and other elegant growths, which ceased suddenly as we reached the black lava at the bottom.

From thence the way led over the most desolate region imaginable. The lava lay as it had cooled, with cracks caused by its shrinkage, from an inch wide to a foot or more, some of considerable depth, and many of them emitting steam or sulphurous vapor. The plain was very uneven and piles or hummocks of cooled lava 10 to 20 ft. high, apparently the result of some outburst, were not infrequent. There were also basins deeply depressed, which were probably the sites of former active lakes.

The locations of activity are said to be constantly changing, as well as their degree of intensity, and every description varies from those given before. Much of the lava is hollow underneath, owing to the liquid lava having flowed from under that which had cooled at the surface, and there are pipes and channels thus formed which, being cracked and broken, make difficult and dangerous walking. The endless variety of forms assumed by the lava require photographs to give any idea of them. Long rolls like tree trunks, wrinkles, sometimes like great shells, old ropes in great abundance, and heaps, like magnified worm casts, are a few of its forms.

Occasionally you come to broken-up lava in heaps or ridges, and it was in surmounting some of these latter that we encountered dense sulphurous fumes, and in the struggle through these, especially on the return trip, when having to climb a considerable elevation over the sharp and jagged edges of a broken-up ridge of lava, with one's nose and mouth partially stopped by a wet sponge or handkerchief tied on, as was necessary to prevent suffocation by the sulphurous acid, it was difficult to meet the extra demand for breath which the exertion required. One of the ladies was overcome by the difficulties of this place, but was dragged through by the guides.

A little beyond this place we came in sight of the Burning Lake. It was at the foot of a rugged descent, the crater having here changed its generally level character for rough cliffs and broken masses of rock and lava. We found seats on blocks of lava, where we could conveniently look down on the fiery lake, from a height above it of 50 or 60 ft., and perhaps 200 ft. from it. It was in form an irregular oval of about 200 ft. wide and 400 or 500 ft. long. I changed my position, for part of the time, to one much nearer, and found a convenient point of observation. The dark grayish surface of the lava lake lay nearly motionless before me. Its color would have been a low red, if not contrasted as it was with the white hot light of the boiling lava adjacent.

Immediately in front, on the opposite side of the lake, was the scene of greatest activity. Lava boiled up from below, throwing columns of the incandescent material occasionally to the height of ten feet or more above the surface of a semicircular space in the lake which was kept open by the violent surging to and fro of the lava for the time in action. The mass of lava thus thrown upward at one time might be estimated without exaggeration at many tons. It had, after rising, a forward flowing motion, subsiding again into the lake, much like the motion of water boiling violently in a caldron. This ebullition was accompanied by profuse discharges of sparks or small ignited masses which fell on the partly hardened lava in front.

Frequently small quantities of the white hot liquid were thrown to a greater height and, falling against the dark background of the perpendicular rock behind, stuck to it and there slowly cooled. This gave rise to a series of figures in great variety; the semblance of ducks, swans, snakes and ghostly forms of animals and human beings were projected on the rock, at a white heat, slowly turning to red and then fading out in the glare, or their places were taken by other forms. Once, when we were all looking on, a spectral figure of a girl clad in long robes rose from the hottest portion of the lake and, throwing out an arm, appeared to grasp a projecting point of rock and cling there, where she hung in the supplicating attitude seen in the well known picture of the Rock of Ages. No wonder that this crater has given birth to numerous myths and superstitious legends.

Another similar point of activity was on the right at the end of the lake, which occasionally threw large jets of lava into the lake in front of it. It had formed a hollow half dome above and against the bank, and while still within 15 or 20 ft. of this lava fountain, I was protected by this screen from the direct heat and glare, as well as from the sparks which were constantly being thrown out.

I here gained a personal knowledge of the nature of these pyrotechnic projectiles and of the manufacture of the so-called Pele's hair, in the following manner. I found the bank on which I was reclining to be composed in large part of that substance mixed with nodules of black glass. Endeavoring to collect some of the former for specimens, I found my fingers stuck full of needle-like particles of glass, and then on moving slightly discovered that my clothes were likewise stuck full of similar pointed arguments, which soon convinced me that my hitherto confortable and advantageous seat was no longer tenable. I thus learned that the fine threads, like spun glass, soft and matted together so that the birds use it for lining their nests, and said by the natives to be the hair of the goddess Pele, were the long-drawn-out tails of particles of black volcanic glass, which melted material seems to float on the surface of the lava, and is blown into the air by gas or steam escaping violently therefrom. The particles have a tendency to form a sharp tapering tail ending in the fine hair-like thread. They are blown on the rocks in large quantities, and the filaments alone go long distances and collect in cavities.

II. THE CRATER OF KILAUEA.

Night came on soon after our arrival at the scene of commotion, so that the daylight no longer interfered with the vivid brightness of the hot lava. Later on, eruptive action commenced, also on the left hand end of the lake. Then the edge of the lake next to its vertical shores lighted up with little jets of hot lava, and finally large cracks opened in the dark, partly solidified surface of the lake, and fresh hot lava seemed to overflow and swallow up the former surface, till the whole showed red and liquid, accompanied with considerable agitation.

After a while this surface cooled off as before—and it was remarkable how rapidly the surface did cool, when the heat beneath is considered. These exhibitions were repeated, with variations, from time to time. Once the cracks opened like the plan of a fortification, with straight lines and angles, representing ramparts, bastions, etc.; and sometimes the openings were curved, and wide spaces sunk, showing the white, hot fluid beneath. In general, the view was unobstructed by steam or smoke, though little could be seen beyond the line of the fiery fluid, but occasionally a dense cloud of sulphurous fog from the rocks behind us would obscure all but the brightest part of the eruption which glared red and sullen in the midst.

I have lately seen the cyclorama of the crater of Kilauea. It does not show what I saw, but greatly exceeds it, both in extent and violence of the action shown. It is finely executed, the effects of light are very artistic, and I can readily believe in the correctness of the representation in other particulars.

Language would fail me, vere I to attempt to describe the sensations excited by these grand displays of the forces of nature, though but on a small scale compared with what has been, but showing the processes in action by which such vart results have been effected, both in the crater itself, of which the burning lake is but a small fraction, and in the whole region surrounding.

The term "crater" is applied to the whole sunken cavity in the summit of the mountain. Its floor is composed of repeated flows of lava, the last of which has left its general level still 500 ft. to 600 ft. below the cliffs, forming the crater's edges. The mountain, like the others in its vicinity, has evidently been built up by successive overflows of lava from its central crater, as is shown by the strata of its vertical basalt walls, which lie horizontally. There is no gap in the walls out of which the lava could have flowed, as in some other volcanoes, but when the fluid lava has escaped from the crater it has been by subterranean or submarine channels to orifices in many instances near the base of the mountain; but oftener, it is presumed, as there is little evidence of the fact, the discharge is made far beneath the ocean's surface. The pit of the great crater has been known to have had a depth of over 1,000 feet.

There are, or have been, a number of open pits, or lakes of lava, at various points in the floor of the crater, one of which I have described. The principal of these is Halema'uma'u, occupying the southwestern part of the crater and having an ever-changing opening of half a mile or more in diameter. Its edges are above the general level of the crater floor, and the fluid lava from it occasionally overflows upon the latter. Islands exist in the lake, which change their form and sometimes appear to float. The banks also change their form, either by falling in or by upheaval, and some of their prominences may exceed in height the crater walls. At irregular intervals of a few months to several years, the lava will suddenly subside, leaving a cavity 600 ft. or more deep, into which portions of the edges may fall, including perhaps places where persons have been standing, unconscious of the danger, but the day before. After these subsidences, the lava gradually rises till the lake is full again.

(To be continued.)

SCIENTIFIC KNOWLEDGE OF THE ANCIENT CHINESE.

THE question of China has been so much to the front lately that an article which appeared in one of the August numbers of the Revue Scientifique, on the knowledge of science possessed by the Chinese, seems very apropos. It cannot be denied that the Chinese of the present day have very elementary ideas on any branch of science. This, however, was not so formerly.

In early times, as far back even as 2000 B.C., we find that science in China had reached a fairly advanced stage. The Chinese possessed undoubtedly a great knowledge of astronomy; inscriptions have been found which prove this. In the "Chou-King," a book of records, we read that Emperor Yao, who reigned 2357 B.C., did much to advance the study of this science. He ordered his astronomers to observe the movements of the sun, moon and stars, and showed them how to find out the commencement of the four seasons by means of certain stars.

We read also that he told them that a year consisted of a little less than 366 days, and as he divided the year into lunar months, he taught them the years in which the additional lunar month ought to be included. It is also known that the Chinese had the annual calendar, that they observed the planets Mercury, Venus, Mars, Jupiter, Saturn and were able to calculate eclipses and knew the difference between the equator and the ecliptic. It is quite probable that the ecliptic was not known of before the Mussulmans occupied the Mathematical Tribunal, which they held for three centuries.

We see, therefore, that the knowledge of astronomy was very extensive. With regard to the meridian, it was apparently unknown to them. M. Chavannes, who is at present professor of Chinese at the College of France, says that it is not mentioned in any astronomical book. As substitute a certain star was observed at the same hour, according to the times of the year, note being taken of its positions with regard to the horizon.

Astronomy has always been closely connected with astrology. By means of astronomy the time was ascertained for the numerous public ceremonies recorded in the imperial calendar; it likewise regulated the affairs of the government. But the calendar has long since ceased to be used for this latter purpose, and the majority of the Chinese population merely look upon it as a means of continuing the mysterious ceremonies and oracles connected with the different positions of the planets. It is ordered in the "Collection of the Laws" that at each eclipse ceremonies should be gone through to deliver the eclipsed sun or moon. At this time therefore an alarm is sounded on the drums, the mandarins arrive armed, utter many objurgations, and thus deliver the endangered bodies.

In the seventeenth century certain Jesuit missionaries arrived in China. On seeing the low state into which the Mathematical Tribunal had fallen, they offered to help it. They found an observatory, containing many instruments, which shows plainly that this branch of science had at one time reached an advanced stage. This decay of science is not to be wondered at when we remember that twenty-two dynasties were brought on the throne by actual revolutions. Nor is this decay confined to astronomy. According to the ancient books and traditions, we find that various branches of science had reached a high degree of culture.

The Emperor Kang-hi, who reigned in the seventeenth century, had a great love of study himself and endeavored to advance the general education in China. The Jesuit missionaries instructed him in geometry and physics. He translated some text books into Chinese.

The Chinese have generally been credited with the invention of gunpowder. A certain document has been found, however, by Archimandrite Palladius, a Russian sinologue, stating that in the ninth century a Persian regiment, under the Chinese sovereign, made known a material similar to wild fire, which was afterward used for fireworks.

Apparently, chemistry has never been studied, unless by a certain sect, the Tao-tse, who spent all their time endeavoring to discover the philosopher's stone and the elixir of life.

The Chinese have not a great knowledge of geology. The mines have been worked without any machinery, and are not very deep; therefore fire damp has rarely been the cause of destruction. Coal was extracted at as early time as 200 B. C. in the dynasty of Han. Al-

though the mode of extraction was very primitive, enough was obtained to satisfy all wants.

About 1861 the government handed the exploration of the mines over to American prospectors. The work, lasting from 1862–64, was directed by Prof. Pumpelli, who at its termination sent the emperor a report and a map of the coal fields. The Smithsonian Institution of Washington have had these documents published; they have also appeared in the diplomatic correspondence of the United States (1864). Later on, Baron de Richtofen did similar work, and found that the coal fields in China are even more extensive than those in North America.

Research work has not been carried far in natural science. In zoology their classifications are quite wrong. The drawings in zoological and botanical books can often scarcely be recognized. Their most ancient work on botany dates from 2700 B. C., and is a treatise written by the Emperor Shen-nung; it is merely enumerative. Another work, the "Rh-ya," dates from 1200 B. C., and shows signs of progress. The "Pen-tsao," an encyclopedia, is, according to M. Bretschneider, of little value.

This Russian investigator speaks of the Chinese as follows: "It is an undeniable fact that the Chinese do not know how to observe, and have no regard for truth; their style is negligent, full of ambiguities and contradictions, teeming with marvelous and childish digressions."

However, in a more recent communication, M. Bretschneider retracts his words and says that it is more that the Chinese will not observe than that they cannot, for Lichi-Tchen, author of several interesting pamphlets, brings forward many facts concerning cultivated plants.

With regard to medical science, it is very elementary. Occasionally here and there a successful doctor is to be found. This lack of knowledge is not to be wondered at, for Buddhism forbids dissection of bodies. In the temple of Confucius a bronze figure is to be found, on which all the different parts are marked where the surgical needle may be applied. This needle is practically the only instrument used in the profession.

The height of civilization in China was reached at the end of the reign of Kang-hi. The gradual decline is supposed to have commenced with the Tartar denomination.—Nature.

PROTECTION AND DISPERSION IN PLANTS.

By JOHN R. JACKSON, A.L.S., etc., Keeper of the Museums, Royal Gardens, Kew.

To Mr. Darwin and Sir Joseph Hooker we are indebted for much of the knowledge we now possess on the subject of what are popularly known as carnivorous plants—namely, those plants which, though belonging to very distinct natural orders, have a similar habit and power of catching small insects and digesting the juices of their bodies for their own sustenance.

This class of plants has for some time past attracted a considerable amount of general interest, and has been the cause of much inquiry into other phenomena of plant life, of which there are numerous branches equally interesting, but the facts in connection with which have not been brought together and elucidated so clearly as those to which we have already alluded.

It is true that such subjects as the motion, means of dispersal, protection and similar matters now form part of the studies of those who take up the consideration of botanical science; but the plants about which this kind of interest is centered are so diverse in character and so widely distributed geographically, besides which there are so many that have never been satisfactorily illustrated, that a few words on their peculiarities, aided by the excellent drawings of Mr. Allen, will no doubt be of some interest to the readers of the Leisure Hour.

It will be seen from the details we shall give of the habit of each individual plant that, though attained in a variety of ways, the one great aim in nature is the perpetuation of its species, which is secured in some instances by a mimicry of other plants, which protects it from destruction; or by security of the seed within the strong walls of its protecting fruit; or, again, by means of feathery or broadly expanded wings, by which the seeds are often carried for considerable distances until they alight on a congenial soil in which to start in life on their own account; or, again, by the presence of external barbs or hooks, by which means the fruit or seed often attaches itself to some passing object, or to the fleece of sheep or other animals, and is so preserved from destruction.

One of the best known examples of protection from the external influences of wind and weather is the well known cocoanut (Cocos nucifera). This palm is a native of the shores of tropical seas, so that when its fruits ripen they are often carried by ocean currents to distant shores, where they are left by the tide, and, after a lapse of sufficient time to enable them to germinate, they become rooted in their new home, forming fresh plants to take the place of those which are worn out by age or that have been blown down by storms or destroyed by other causes. In a fruit that is exposed to the action of sea water for any length of time, or that is buffeted and tossed about by the waves, it is apparent that if vitality is to be maintained in the germ or embryo some special protection is necessary, and this we find is provided for by nature, first, in the thick fibrous husk or coating, which forms the outside covering of the whole fruit, and which in itself is impervious to moisture; and next in the hard, bony shell, which effectually protects the germ inside and the kernel upon which the germ feeds, until it has established its roots in a suitable soil and climate. Besides this wonderful system of protection which Providence has so abundantly supplied to the cocoanut, the triangular shape or form of the husk is so arranged that one of the sharp ridges makes an excellent keel, thus enabling it to travel through the water more easily and rapidly than it otherwise would.

Another familiar example of protection and security of germination is to be found in the two species of mangrove (Rhizophora Mangle and R. mucronata). These trees, as it is well known, are natives of muddy swamps on the seashore in the tropics or in estuaries under tidal influence. Their peculiarities are, first, on account of their roots, which branch in all directions, stretching out far and wide, and forming a dense tangled network of stout woody meshes, so that at low tides they are quite exposed to view, and people can even walk among then. The other peculiarity is in the fact of the seeds actually germinating before they leave the parent tree, and this is effected in the following manner. When the fruits are fully grown they are from about one and one-half inch to two inches long and somewhat of an inverted pear shape, the thickest end being attached to the branch, and while so attached germination of the seed within the fruit takes place, by sending down from the narrow point a straight rod-like or stick-like root, which sometimes grows to a length of two feet before it separates from the branch; by this time it is about as thick as the finger, and sharply pointed at the lowest end. It is also studded at this point with small protuberances. As this rod-like root falls from the tree, it partially buries itself in the mud, and from the small protuberances rootlets are given off, and a young tree starts into existence.

Such, then, are two familiar examples of the protective care exercised by nature in guarding the germs from any outward adverse influences until such times as the plants are able to take care of themselves. There are many similar instances among plants equally well known in different parts of the world, but, on account of their being well known, the facts connected with their life history are seldom thought about.

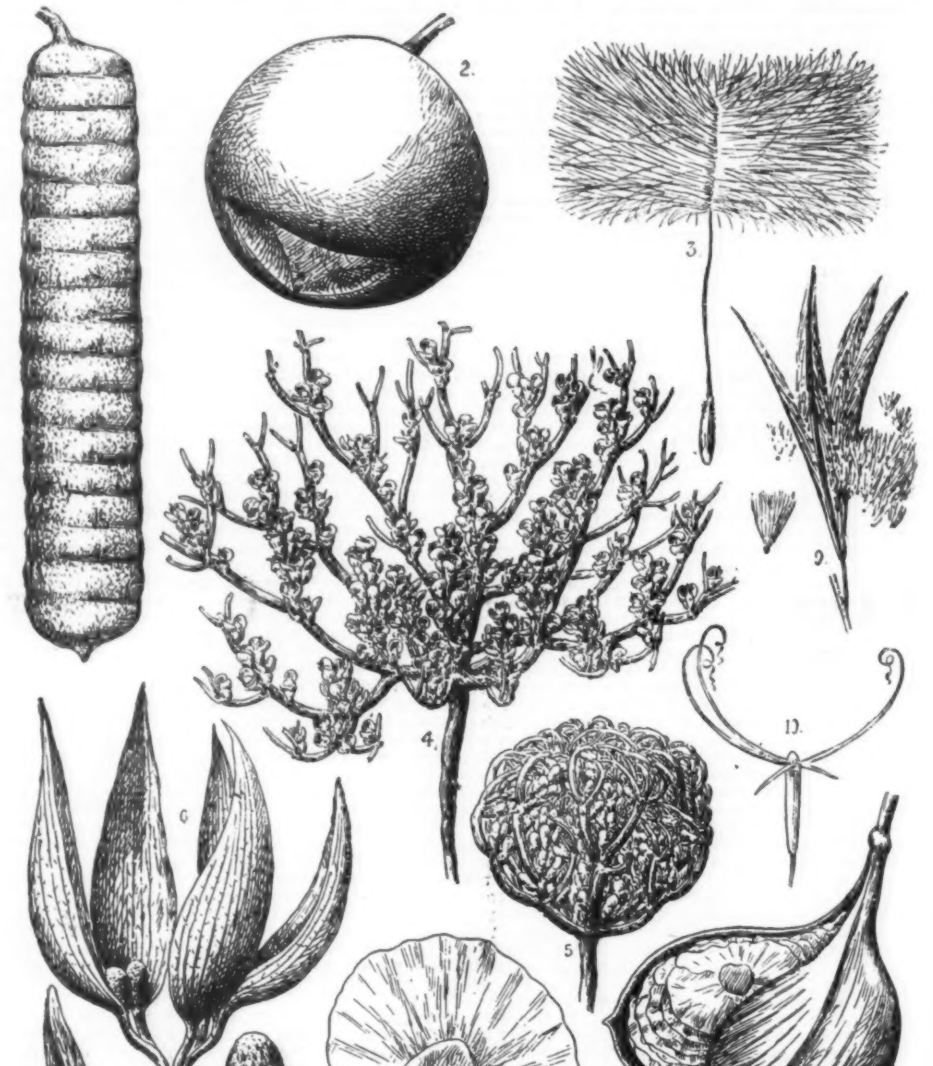
Our illustrations are selected mostly from plants that are less popular, and in describing them we shall classify them, as far as possible, in groups, according to their habits of protection, diffusion, or otherwise, and not according to their botanical affinities.

In the first group will be found those plants that possess hygroscopic properties—namely, the power of contracting in drought and expanding in moisture, and by this means protecting their seeds till they alight on a moist and favorable soil. The best known example of this is shown in Figs. 4 and 5. This plant is commonly known as the Rose of Jericho, and sometimes as the Resurrection Plant. It is the Anastatica hierochutica of botanists, belonging to the natural order Cruciferæ, and is closely allied to the horseradish of our gardens. It is a native of the dry waste lands of Northern Africa and Palestine and the sandy deserts of Arabia. The low bushy habit of the plant, seldom exceeding four or five inches high when fully expanded, is well shown at Fig. 4, where it is represented after the flowering period, when the leaves have fallen off, but while the plant is still under the influence of moisture. In drought it easily becomes uprooted, the branches curl inward, as shown in Fig. 5, forming an irregular ball, so that it is rolled about and easily carried by the wind for considerable distances. Upon drifting into a pool or stream the plant opens and the branches again expand, the small fruits burst, and the seeds are distributed in situations where they germinate and produce young plants. The dried plants are often seen in collections of curios, and retain their hygroscopic character for many years, expanding when placed in water and closing again when dry. In consequence of this peculiarity the plant has received its common names, and tradition states that it originally opened on the birthday of our Lord.

Another plant which is sometimes also called Rose of Jericho is the Mesembryanthemum tripolium, a low-growing plant of the Cape of Good Hope, the fruits of which, in their dried and closed state, Fig. 33, are about three-quarters of an inch in diameter, and have somewhat the appearance of a button; if placed in water for about ten minutes, they open in a beautiful rosette form, Fig. 34, the center being of a deep crimson color. Thunberg, who visited the Cape in 1774, describes the plant in the following quaint manner: "When it is put into water it gradually opens all its seed vessels and exactly resembles a sun, and when it becomes dry again it contracts itself and closes by degrees. This is no less a necessary than singular property, which points out the admirable institution of an all-wise Creator; inasmuch as this plant, which is found in the most arid plains, keeps its seeds fast locked up in time of drought, but when the rainy season comes, and the seeds can grow, it opens its receptacles and lets fall the seeds in order that they may be dispersed abroad."

A more common system of dispersal is that which is secured by winged fruits and seeds, such, for instance, as we find in the maples and sycamores, where the winged fruits are mostly in pairs, but sometimes in threes, as shown in the maple (Acer campestre), Fig. 48. Each of these capsules or fruits contains a single seed, and as they ripen they often separate at the base and so form a single wing; but whether separated or united they travel by the aid of the wind for some distance from the parent tree, finally falling to the ground, where they germinate in the following season, forming crops of seedling maples.

In the natural order Leguminosæ a large number, and some of the most remarkable, of these winged fruits are found. The largest and most striking is the pod of Centrolobium robustum, Fig. 46. This is often six or seven inches long and three or four inches wide, and has some resemblance to a single fruit of the maple. The lower or seed-bearing portion is globular, covered with long, stiff prickles, evidently as a defense for the seed inside. The upper or winged portion is of a thin woody nature, defended on the back ridge with a stout, sharp spine. Armed as this pod is, it would be protected for a long time from destruction, and the strong woody character of the wing would carry it through many vicissitudes of wind or rain or other



PROTECTION AND DISPERSION IN PLANTS.

opposing elements. This is all the more necessary as the tree which bears this pod is a large hard wooded one growing in the dense forests of Brazil.

Another example of a winged legume is shown at Fig. 40, which is the pod of Platypodium elegans, also a Brazilian tree. The pod, however, is different from that last described, inasmuch as the stalk is at the thin end of the wing and the seed-bearing part at the extremity, exactly the reverse of that in Centrolobium.

The same arrangement is seen in Fig. 55, which is a pod of an allied South American genus—Platymiscium. The venation or veining of the wing in this pod is different from those already referred to, imparting as it does a leaf-like appearance, besides which the pod has along its suture and down the back a very prominent vein.

Closely allied to this plant is Pterocarpus erinaceus, a large tree of west tropical Africa, the wood of which is hard, of a deep red color, and known as African Rosewood. It yields a brittle resinoid astringent substance known as African Kino. The pods, as shown at Fig. 50, are flat, nearly round, usually thick and hard in the middle or seed-bearing part, and covered here with short spines, while the rest is attenuated into a thin membranous wing, with spines distributed more or less over the whole surface. The wing, of course, assists the dispersal of the pod, while the spines protect it from destruction, and these spines are thicker and stronger, as they are in other plants, just around the seed, where the greatest amount of protection is needed.

Another closely allied plant is Machærium firmum, the winged fruit of which is represented at Fig. 51. It is a large Brazilian tree, and is supposed to be one of the trees which furnish Brazilian Rosewood.

Perhaps one of the most peculiar of winged fruits is that of Paliurus aculeatus, commonly known as Christ's Thorn. In consequence of its being supposed by some to have been the plant of which the Crown of Thorns, placed upon the head of the Saviour before His crucifixion, was formed. It is a shrubby plant, native of Southern Europe and Western Asia. It has flexible branches, which could be easily twisted or plaited, and the leaves are armed with stout spines. The fruit is hemispherical, three celled at the base, and expanded at the top into a broad thin line, the entire fruit giving the idea of a head crowned with a broad brimmed hat. Figs. 41 and 42 show the under and upper sides of these singular fruits.

Under the barbarous name of "Boa-tam-paijang," a species of Sterculia (Sterculia scaphigera) produces clusters of remarkable follicular fruits of a papery texture, with parallel nerves running from base to apex. These follicles burst at an early stage of the ripening of the seed which they contain, forming a boat-shaped wing-like appendage, at the base of which the seed is seated. They not only form a protection to the seed when growing, but would no doubt assist their transport should they fall into any current of water. The boat-shaped follicles are well shown in Fig. 6, and a seed about half natural size at Fig. 7. A remarkable character in connection with the seeds themselves is that when placed in water they swell to an enormous size, forming a gelatinous mass, which is sweetened and eaten like jelly by the people in Siam and China, where the plant grows. It is recorded by Sir R. Schomburgk that in localities where the trees abound by the roadside their fruit sometimes drops to the ground in such quantities that if rain ensues such a mass of glutinous jelly is formed as to render the passage of the road on foot or horseback a matter of difficulty. The fruit of an allied species (Sterculia campanulata), a large tree of Pegu, Java, and other Eastern countries, is shown at Fig. 8. It will be seen that the inflated covering of the seed in this species is more hooded and not boat-shaped as in S. scaphigera.

A remarkable shuttlecock-like fruit is shown at Fig. 52. As will be seen, it has four leaf-like wings at the apex of the fruit, so that in descending from the tree its progress is gradual and spiral like a miniature shuttlecock. It is the fruit of a Japanese tree, a species of Buckleya, and is closely allied to the Indian sandalwood. The nearest approach to this fruit in form are those belonging to Dipterocarpus and Lophira, where, however, two wings only are developed beyond the fruit, and these sometimes to the length of five or six inches.

Turning now from winged fruits to winged seeds, we often find a good deal of similarity in shape or even in size. Thus, to compare Figs. 44 and 49 with Fig. 51, there would appear to be a general resemblance; the last, as we have already seen, is a perfect leguminous fruit, while the two former are respectively seeds of the mahogany (Swietenia Mahagoni) and of a closely allied African plant (Soymida rhopalifolia). In both cases the fruits are woody and open naturally when ripe, setting free the seeds, which are carried, often long distances, by the wind, when perchance they alight upon a congenial soil and spring into new plants.

In many cases, however, the seeds are not crowned by the wing, as in the instances just mentioned, but are surrounded by it as in Blumieria phagedanica (Fig. 43), a large number of which seeds are packed together in a long flat woody fruit. The plant belongs to the periwinkle order, and has a close ally in the paddle tree of British Guiana (Aspidosperma excelsum), a fruit of which, showing the seeds closely packed inside, is shown at Fig. 11, and a separate seed at Fig. 12.

The fruit opens naturally, as shown in the drawing, and the seeds then fall out. The same arrangement occurs in plants of widely distinct natural orders; thus at Fig. 2 is shown a globular fruit, sometimes as large as a child's head, which is the produce of a slender growing plant of the cucumber family, native of Java (Zanonia macrocarpa). When ripe this fruit opens naturally by a triangular slit at the top, the three sides curling inward, and so letting the very numerous seeds escape by falling out, as the fruit is pendant. A very thin, transparent membranous wing encircles the seeds (Fig. 39), so that they travel before the wind for long distances.

In another natural order—Bignoniaceæ—nearly all the plants included in it are marked by flat, woody fruits, which separate when ripe into two valves, setting the winged seeds free. The best known plant in the order for the size of the pods and for the beauty of these delicately winged seeds is Oroxylum indicum. It is an Indian tree, and the pods often measure two feet long by three or four inches broad. A seed is shown at Fig. 45. The membranous wings of all these seeds form beautiful microscopic objects.

Another flat winged seed is shown at Fig. 47, and the pod from which it was taken at Fig. 1. These are the seed and pod of Entada africana, a much branched leguminous tree of Sierra Leone, Senegambia, and Fernando Po. The pod is flat and papery, with from fifteen to twenty one-seeded divisions; in drying, these divisions separate by their edges transversely, throwing out the seeds, which appear almost like thin shavings of a light colored wood with the seed in the middle. In falling, the seeds revolve rapidly and form a spiral gyration.

Another form of seed capable of being carried long distances is that which is crowned on its summit with a feathery pappus, composed of numerous silky hairs, such as those shown in Figs. 3, 9, 13, 14 and 29. The first is a seed of Strophanthus Kombe, a plant belonging to the periwinkle order (Apocyneæ) and native of tropical Africa. The seed, which is the small oval shaped base, as shown in the drawing, is crowned with a long, stiff, thread-like appendage, the summit of which is again crowned with a mass of very fine white silky hairs, known as the pappus. An immense number of these seeds, each with the pappus attached, but folded up close to the stalk-like appendage like a closed but inverted umbrella, are packed away in a cylindrical fruit, green when fresh and not unlike a small, straight cucumber, but becoming brown, hard and woody when ripe or matured, at which stage it bursts open by a long slit down one side, and the seeds being thus set free, the pappus hairs immediately expand, forming, as it were, a kind of shuttlecock. In this condition the seeds will travel before the wind for very long distances until the slender stalk becomes snapped. The actual seeds of this species, minus the pappus, have of late years become a regular article of commerce in the English drug markets, being used in medicine for affections of the heart.

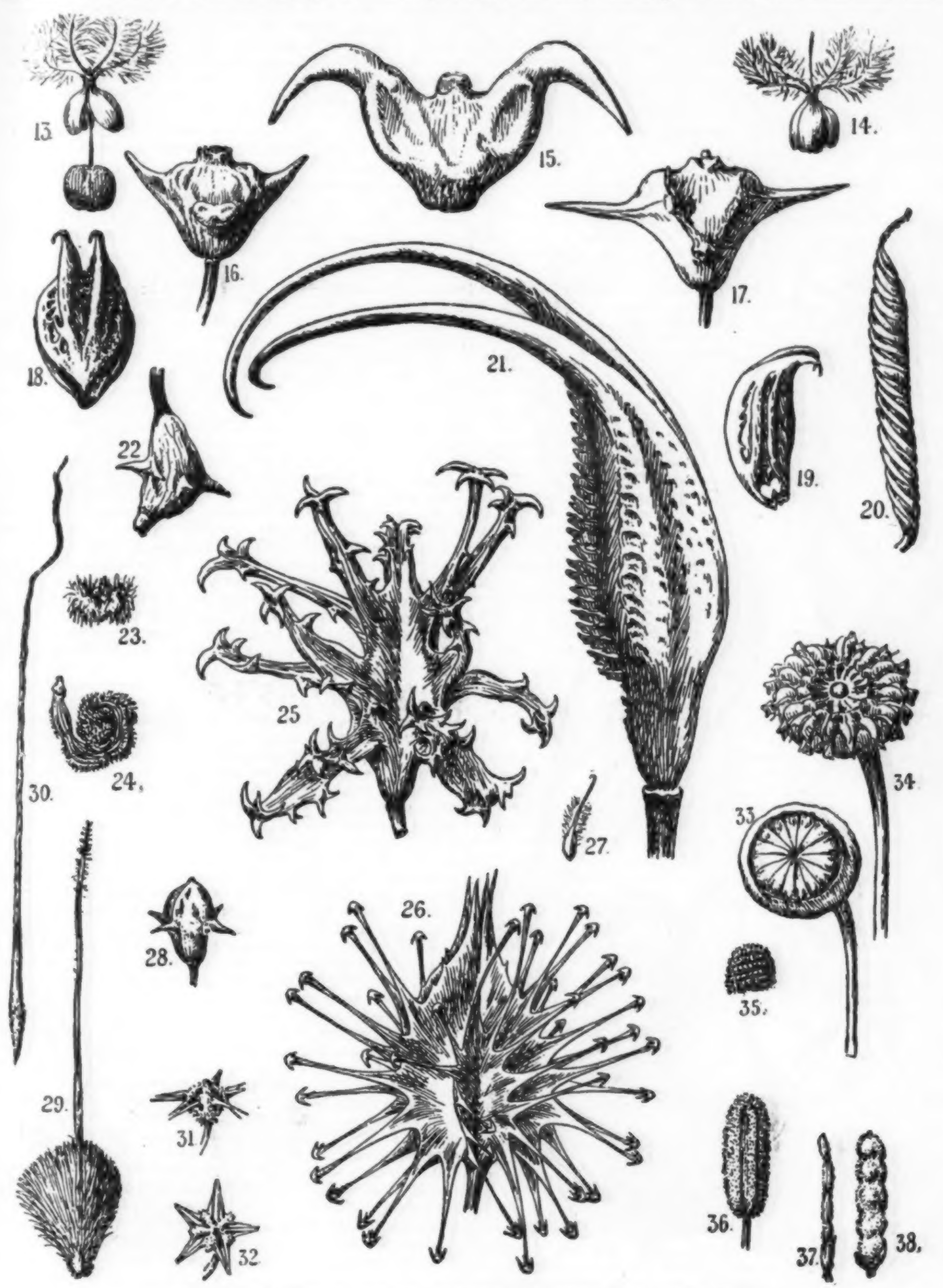
Though we have taken Strophanthus as an illustration of this form of seed, the seeds of most of the plants belonging to the order are more or less similar. Indeed, in several natural orders widely distinct from each other we find a silky pappus crowning the seeds, notably in the Compositæ, as illustrated by the dandelion, as well as in the Onagrariæ, of which the spines of Epilobium, or willow herbs, are good examples. A fruit of Epilobium roseum in the act of bursting and emitting its numerous feathery seeds is shown at Fig. 9.

At Figs. 13 and 14 are shown another and still more curious form of a pappus-crowned seed. These are the seeds, or the single-seeded fruits, of the Cape silver tree (Leucadendron argenteum), the silvery leaves of which are now so much used for decorative purposes at Christmas time, as well as for book markers. The seeds are buried in a globular cone-like fruit or receptacle, about the size of a large orange. A single seed is shown at Fig. 13; but the peculiar feature in this seed is that the crown of pappus hairs is connected with a scale-like inflated cap, which works up and down, as it were on a pivot, carrying the pappus with it; when down the cap falls over the seed, as shown in Fig. 14. This forms some slight protection to the seed when at rest, but when traveling through the air the cap, rising with the pappus to the top, causes it to become more balloon-like, so that instead of immediately dropping to the ground it is kept up for some time, and so assists its dispersal. This plant belongs to the Proteaceæ, as does also that shown at Fig. 29, which is a seed of Protea plumosum. In this case the seed, or more properly the fruit, which is single-seeded, is covered with short stiff hairs, which not only protect it from external harm, but also assist it in its distribution.

We must now turn to the consideration of a few examples of fruits of more or less curious formation, the forms or shapes as well as the armature of which serve principally for protection, but also, at the same time, help their conveyance by the means they have of attaching themselves to any moving body.

Certainly the most singularly striking of this kind of fruit is to be found in the order Pedalineæ, some illustrations of which will be found at Figs. 18, 19, 21, 22, 25, 26, and 28. Figs. 18 and 19 are different views of the same fruit—namely, those of Martynia diandra. It will be observed that at the apex of the fruit are two hooks; these are very rigid and very sharp, so that they protect the fruit from destruction, and this, more particularly, as the whole fruit is very hard and woody, so that it cannot be devoured by animals which may be feeding upon the undergrowth in which the plants grow. On the contrary, they frequently hook themselves into the wool or even into the skin of such animals, and thus get carried from one place to another; further than this, they are often a great annoyance to travelers, as they become fixed to their clothing, from which they are removed with difficulty.

In the plains of South America a yet more formidable plant is found in Proboscidea Jussieui (Fig. 21),



PROTECTION AND DISPERSION IN PLANTS.

the curved horns of which are often five or six inches long, besides which the whole fruit is covered with sharp, stiff spines.

A less formidable fruit is that of Rogeria adenophylla (Fig. 22); it is a close ally to the former, and is armed with stout spines.

The most diabolical of all is that shown at Fig. 25, which is that of the South African grapple plant (Harpagophytum procumbens). As will be seen, the fruit is furnished on all sides with very strong branched sharp hooks, which get entangled with the clothing of travelers, causing great annoyance. The hooks are so sharp and curled in all directions that they readily lay hold of the fingers, even with careful handling, and penetrate the flesh. The plant is a prostrate herb, and growing, as it does, among long grass, it is readily taken into the jaws of animals as they feed, and who are described as roaring with the pain thus caused, from which they are utterly helpless to extricate themselves.

An allied plant, Harpagophytum leptocarpum, a native of Madagascar (Fig. 26), has a fruit quite as difficult to get rid of when once it has become attached to the clothes or the flesh either of man or beast. The small hooks of this are as sharp as needles, and in form are identical with an ordinary grapnel. It is, therefore, easy to understand how such fruits get dispersed or transported to distances.

A similar form of protection is seen in Pedalium murex (Fig. 28), a branching annual plant of India, belonging to the same family; again, in Tribulus terrestris (Figs. 31 and 32), also a low trailing Indian plant, belonging to the order Zygophylleæ. In times of scarcity these prickly fruits are ground into a powder and made into bread by the people.

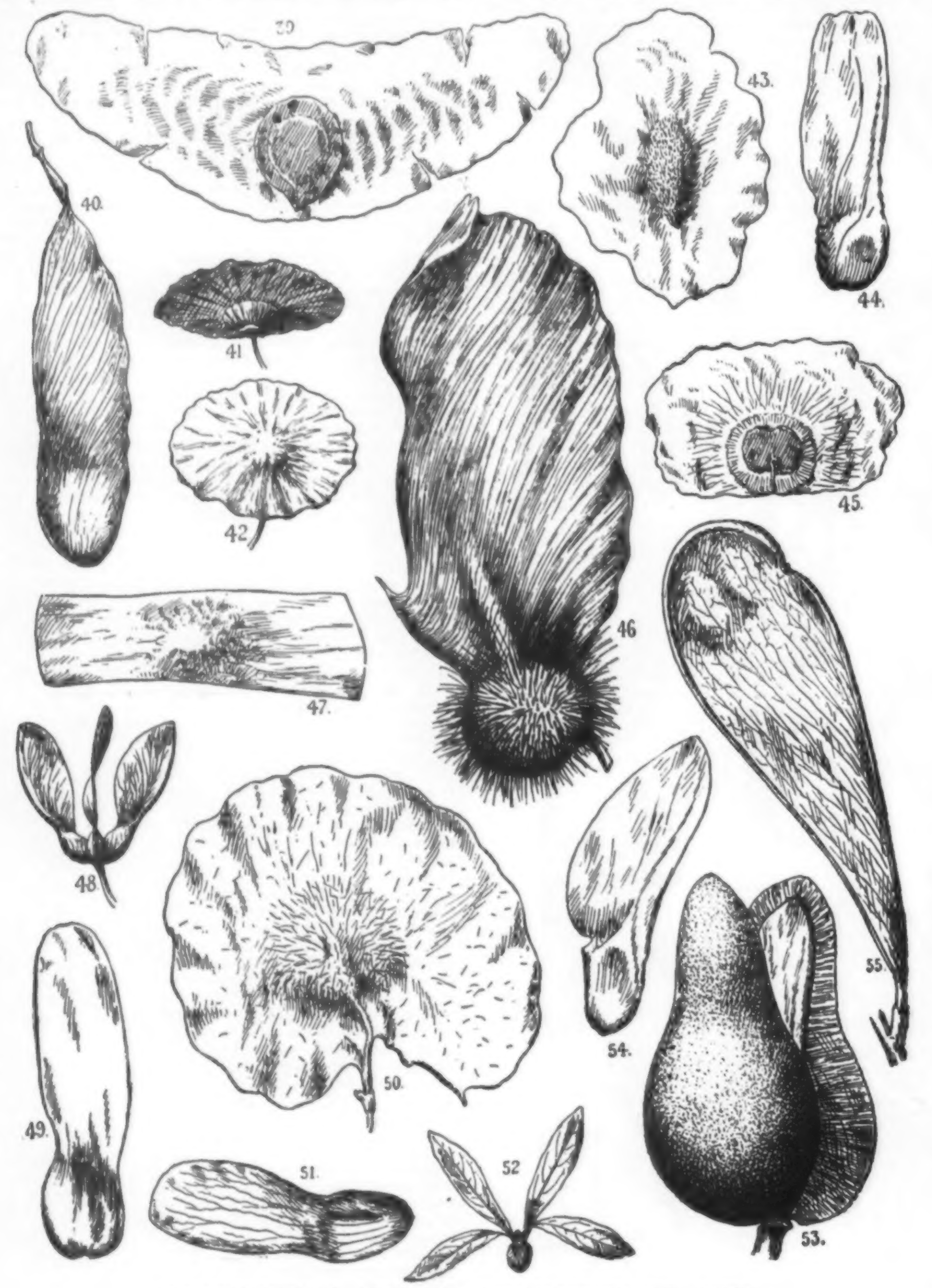
Other illustrations of fruits that are both protected and dispersed by the aid of their prickly appendages are shown in Cenchrus tribuloides, a native grass of South America (Fig. 23); Scorpiurus vermiculata, a leguminous plant found in cornfields in the Mediterranean region (Fig. 24); Medicago pentacycla, also a leguminous plant of Southern Europe (Fig. 35); Hedysarum coronarium, closely allied to the last, a native of Spain and Italy, in fields and meadows—the plant is commonly known in English gardens as French honeysuckle (Figs. 37 and 38); Geum urbanum, a perennial herbaceous plant belonging to the rose family, and found on the borders of copses and hedgebanks in this country (Fig. 27); Pisonia aculeata, a straggling shrub with thorny branches growing in Southern India, Ceylon, and other tropical countries. The strong hooked spines or thorns of the branches are described as causing much annoyance to travelers in consequence of their becoming entangled in their clothes or flesh, and the spines with which the fruits are clothed are covered with a glutinous substance, which causes them to adhere to the wings of birds to such an extent as to interfere with their power of flight, so that they are easily captured. This fruit is shown at Fig. 36. A very singular fruit of the same character, but without the glutinous matter, is that of Trapella sinensis (Fig. 10). It belongs to the same natural order as the grapple plants, and is a native of China. As will be seen, the fruit is three sided, each side terminated in a long horn, curved at the apex, alternating with three strong, sharp, straight spines.

At Figs. 15, 16 and 17 are represented the fruits of three forms of Trapa—Trapa bicornis, T. natans and T. bispinosa. These are generally known by the name of water chestnuts, and, as the name would imply, are the produce of aquatic plants, the first a native of China, the second a European species and the third an Indian. Each species has a hard woody shell armed with very strong spines; in the Chinese species these are curved downward, and as the whole fruit is of a dull brown color, it has a general resemblance to a bull's head. The woody covering protects the seed inside from decay, and the sharp spines prevent its destruction from various forms of attack. The kernels, which are white and nut-like, are eaten, and in India they form a very large and important article of food, being ground into a kind of flour and used for making bread, puddings, etc.

The woody covering of fruits is often developed to an enormous thickness, forming an absolute protection to the seed inside, being quite impervious to water or to any atmospheric conditions to which the fruits may be exposed. Such, for instance, are the huge globular fruits of the Brazil nut, and the several species of monkey pots of the Brazilian forests, which, at the proper time of ripeness, open naturally by a lid and disperse their seeds, the fruits themselves, after the exit of the seeds, forming excellent water vessels. A woody fruit of this nature is shown at Fig. 53; it is that of the so-called Australian pear (Xylomelum pyriforme). It belongs to the natural order Proteaceæ, and is confined to Australia. The fruit is the shape of an inverted pear, with the stalk at the widest end; when ripe it opens spontaneously by a lateral slit, setting free the winged seed (Fig. 54), which has some similarity to the mahogany seed (Fig. 44).

Another form of fruit in which nature has arranged for protection and dispersal is shown at Figs. 20 and 30. The first is a spiral fruit of Helicteres Isora, an Indian tree of the Sterculiaceæ. The fruits are known in India as "Twisted Stick" or "Twisted Horn." From their screw-like form they work themselves readily into the wool of sheep and such like animals, and thus get carried to distant places; the same may be said of Stipa spartea (Fig. 30). This is the awn of a grass, a native of the Red River colony, where it causes an immense amount of inconvenience to sheep, entering the wool by its sharp point, and penetrating to the skin or even to the flesh by its screwlike movement, often, it is said, causing the death of the animals.

The plants cited in the foregoing remarks as illustrating the subject of dispersal and protection, though numerous, are indeed only a few typical examples of what might be brought forward on a matter which has a great amount of interest for an observer of Nature.—Leisure Hour.



PROTECTION AND DISPERSION IN PLANTS.

AUTUMN COLOR IN THE PINES.

THE color in the Pines is unusually brilliant this autumn. Many of the white oaks are carrying bright scarlet leaves, while the foliage of the chestnut oaks takes on more of a yellow tinge. Never have the various species of black oaks made a more characteristic display than at this time. The hues range from deep crimson to bright scarlet, while the leaves on some trees are still green, with here and there blotches of red, as if they had been spattered with blood. The section of black oaks is puzzling, so widely do the leaves vary, often on the same tree. On some branches the leaves are but slightly lobed, while those on other branches of the same tree are deeply and narrowly lobed. The white oaks, too, have marked individuality. A large tree in my garden has certain branches to which all the leaves cling through the winter, and only loosen their hold in late spring, when the swelling buds push them off. The rest of the branches lose every leaf in autumn. They all turn to a uniform bright red—those that fall as well as those that remain.

The foliage on some of the sweet gum trees here is a rich dark purple, while on others near by shades of crimson and yellow prevail, and these trees take on the same colors each year. A sweet gum which turns to purple one autumn is always purple, while a tree once dressed in crimson and gold is always the same. But the sour gum, Nyssa, never shows such diversity of color, its leaves being uniformly a bright scarlet. The white maples show the effect of the frost more than most trees. The leaves that were bright yellow a few days ago are now mostly brown and withered, while some of the swamp maples remain a blaze of red. Many of the sumachs still hold their scarlet leaves and fruit clusters. The yellow of hickories and birches is uniform and constant among the varied tones of the sassafras and dogwoods, many of which are yellow here, although, as a rule, red is the prevailing color.

The shrubs, too, make brillant masses of color, especially those in the heath family. The vacciniums are purple, crimson and scarlet; andromedas gleam through various shades of red to a bronze purple, while the varied shades of red in Leucothoë mingle with the yellow of Clethra and Azalea viscosa. The fruit of the black alder shines brightly red among its greenish yellow leaves and contrasts well with the red-brown foliage of Alnus serrulata near by. Baccharis, with its plumy pappus, looks at a little distance like masses of white flowers, and mingling with the autumnal color is very ornamental, but the wild roses are a disappointment. The hips at this time of year are usually plump and bright red, but now they are blackened and look almost charred with the excessive heat and drought. The leaves of the tall blackberry are red and purple, while those of the sand blackberry, Rubus cunifolius, are still green, and the running swamp blackberry, R. hispidus, is always attractive with its rich shades of color, creeping among the grasses and sedges. Very handsome, too, are the cranberries, trailing through the sphagnum with purple and green leaves and scarlet and crimson fruit. Ampelopsis and different species of smilax are clambering everywhere, mantling dead trees and every other unsightly object with the splendor of the season, and all this wealth of color mingled with the green of the pines, cedars, hollies and laurel, is beautiful beyond expression. And yet—ought I to confess it?—we are hardly satisfied with the display made on these low levels. If we could only see a forest sweeping triumphantly up a mountain slope, or a broad landscape billowed with wooded hills and deep valleys! Only in scenery of this kind is the pomp and magnificence of an American autumn fully unfolded.—Mary Treat, in Garden and Forest.

[FROM GARDEN AND FOREST.]

TREE CULTURE—AN INTERESTING EXPERIMENT.

WHEN in Holland last summer I spent a day in the latter part of July, at the request of Professor Sargent, in visiting the Pinetum Schoberianum, or plantations of coniferous trees belonging to Mr. J. H. Schober, on his estate called Schovenhorst, in the town of Putten, some thirty miles northeast of Utrecht. These plantations are very extensive, some six hundred acres, if I remember correctly, being devoted to them, and they contain probably the largest and most complete collection of conifers from all parts of the world, except, of course, the intensely tropical regions, that has ever been brought together. Mr. Edward Downes, the accomplished United States consul at Amsterdam, accompanied me, and Mr. Schober himself was there to conduct us through the woods and fields. A more charming and intelligent gentleman it would be difficult to find; and, although light showers were frequent during the day, according to the summer practice of Holland, and our host was long past seventy, he led us about with a vigor, energy and enthusiasm which formed the envy of the younger men of the party.

Mr. Schober is a wealthy lawyer of Utrecht, and, like the wise man he is, he has long cherished a passion for the cultivation of trees; and this passion he has directed toward a most practical and patriotic object. In Holland there is a great extent of land that in former ages formed the seashore; and in these dunes the soil remains worthless for agricultural pur-

poses. With whatever crop might be attempted, whether grain, grass or vegetables, the expense would be more than the product, and so the land is substantially left without culture; yet with coniferous trees the case is different. Hence the traveler frequently passes in Holland, as in other parts of Europe, plantations of Scotch or Austrian pines occupying these sandy lands where nothing else of value could well be made to grow. These plantations cost little, require no care, and by the annual dropping of their needles tend to some improvement of the soil; while at the end of the proper period the firewood they furnish is a substantial thing and always finds a paying market.

In this situation Mr. Schober has struck out from the common course, and, instead of planting Pinus sylvestris and P. Austriaca, he has started to determine what trees are really best worth planting and cultivating in these sands; and for this purpose, as I have said, he seems to have ransacked the whole temperate zone in all the continents. But I cannot do better than to give his list as follows:

Abies amabilis
" magnifica
" balsamea
" brachyphylla
" bracteata
" Cephalonica
" var. Appollinis
" var. Reginæ Amaliæ
" Cilicica
" concolor.
" firma (bifida)
" Fraseri
" grandis
" Gordoniana
" Mariesii
" nobilis
" Nordmanniana.
" " glauca
" Numidica
" pectinata
" Pinsapo
" " glauca
" Sachalinensis
" Sibirica
" subalpina.
" Veitchii
" umbellata
" Eichleri
Picea Ajanensis aurea
" " alba
" " cœrulea
" Alcoquiana
" Engelmanni
" " glauca
" " argentea
" excelsa
" " eremita
" " Cranstoni
" " aurea
" " compacta nana
" " " pyramidalis
" " " inverta
" " " Remonti
" " Finedonensis
" Jezoensis
" pungens
" nigra
" " doumetii
" obovata
" " Japonica
" orientalis
" polita
" Schrenkiana
" rubra
" Khutrow
" Morinda
" orientalis aurea
" acicularis
" Omorika
" Glehni
" Dicksonii
" Sitchensis
Larix Europea
" Japonica
" leptolepsis
" microcarpa
" Kæmpferi
Cedrus Libani
" Atlantica
" Deodara
Pinus Austriaca
" contorta
" densiflora
" Laricio
" " stricta
" " Calabrica
" Thunbergii
" monophylla
" Fremontiana
" montana
" uncinata
" Pumilio
" Pinaster
" Brutia
" Pyrenaica
" sylvestris
" resinosa
" Jeffreyi
" ponderosa
" Benthamiana
" rigida
" serotina
Pinus mitis
" Tæda
" Cembra
" " Sibirica
" " pumila
" Strobus
" Koraiensis
" Sabiniana
" Balfouriana
" Balfouriana, var. aristata
" muricata
" Lambertiana
" Bolanderi
" Coulteri
" macrocarpa
" excelsa
" Monticola
" tuberculata
" Peuces
Sciadopitys verticillata
Sequoia gigantea
Cupressus intertexta
" Lawsoniana
" " alba.
" Nutkaensis
" thyoides
Retinospora ericoides
" obtusa
" pisifera
" squarrosa
Thuya gigantea
" occidentalis
" " Hoveyi
" " pendula
" Japonica
" Wareana
" Vervæneana
" Bodmeri
" gigantea aurea
" " Standishi
" Spathi
Thuiopsis dolabrata
" " robusta
Librocedrus decurrens
Juniperus communis
" Virginiana
" " pendula
" " variegata
" " albo spica
" " glauca
" " aurea spica
" Japonica aurea
" Schotti
" drupacea
" elegans
" cinerascens
" sabina
" communis aurea var.
" Oxycedrus
" Chinensis
" pyramidalis
Tsuga Mertensiana
" Brunoniana
" Canadensis
" Pattoniana
" Sieboldii
" Caroliniana
Pseudotsuga Douglasii
" pendula
" argentea
" glauca
" Schovenhorst seedling
Athrotaxis Doniana
" laxifolia
" selaginoides
Araucaria imbricata
Cryptomeria Japonica
" " argentea
" " falcata
" " variegata
" " compacta
" " elegans
Taxus baccata
" " pendula aurea
" " pyramidalis
" cuspidata
Widdringtonia cupressoides
Cephalotaxus Fortunei
Torreya Myristica
" Californica
Biota Japonica filiformis erecta
Cunninghamia Sinensis

In one of his pamphlets Mr. Schober furnishes an interesting catalogue of plants that are not winter-hard, and were much injured or entirely killed by the winter of 1881:

Abies bifida
" firma
" Pindrow
" acutissima
" Japonica
Araucaria imbricata
Arthrotaxis selaginoides
" cupressioides
" Guineana
Biota orientalis
Cephalotaxus pedunculata
" Fortunei
Cephalotaxus drupacea
Different varieties of Cupressus
Frenela australis
Pinus densiflora
" Fremontiana
" ovatia
Sequoia sempervirens
Torreya nucifera
" myristica
" grandis

There are several separate plantations of these trees at Schovenhorst, and no two of them seem to be of precisely the same age. The first planting dates back to 1848. The rule universally observed in groves of Scotch pines, of putting the trees in straight lines at very small distances from each other (from three to six feet apart), has been adhered to by Mr. Schober. This close planting forces the growth upward, and leaves no room for lateral expansion, except where an extra vigorous tree crowds away its neighbor and seizes the space for itself. Every two or three years the trees are measured and the measurements recorded. The circumference of each tree is taken at one meter above the ground, and its total height in meters is put down, showing how much it has grown since the last previous measurement. According to the measurements recorded for 1892, the tallest tree, an Abies pectinata, had then reached the height of nineteen meters, or sixty-two feet four inches, and its circumference was 1·25 meters, or four feet and one and a quarter inches. Next to this was a Pseudotsuga Douglasii of 18·50 meters height and 1·48 meters circumference. I saw no record of the later measurements.

But rapidity of growth and ability to resist the climate do not constitute the final test. The last point of all to be determined will be the quality of the wood. For this purpose trees of each kind will be cut down, and when the specimens of the wood are dried, they will be scientifically examined to determine their strength, their power of resistance, their durability and their relative value as fuel. In order to arrive at this final solution of the problem which Mr. Schober has in view, it is his estimate that at least forty years more will be required; and, as he cannot expect to remain as long as that in this world, he proposes to hand the establishment over to the Dutch government on its promising to take care of the plantations, and to see that the enterprise is carried to its full conclusion.

I was there too short a time to form any opinion as to the comparative prosperity of the different species of trees; yet it was impossible not to see that one of the most thrifty kinds was the Douglas fir. That variety of the Picea pungens known as the Menziesii Parryana was likewise very vigorous and promising. I noticed also that none of the pine family and none of the Tsugas seemed to be equal to those two in growth or beauty. Most of the Japanese conifers wore a discouraging appearance, except, perhaps, the Picea polita. But I left Schovenhorst with intense admiration for the zeal, the devotion, the scientific knowledge and the indomitable patience of its owner.

New York. C. A. DANA.

THE WINTER CANTALOUPE.

IT is not generally known that there are several varieties of cantaloupes which are distinctively slow in ripening, and may be some months in doing so after they have been pulled from the vine. We know this to be true with regard to some apples and pears, some of which require several months before they are fit to eat. They are put away in their green state, and after a longer or shorter period, by some hidden process, became mellow and ripe. The cantaloupe is generally so perishable that it lives only from one to three days after it has been separated from the plant, and can be transported but a few hundred miles.

But there are winter varieties of the melon that can be kept like apples or pears and will ripen in November and along until the last of winter. We know of four varieties of the winter cantaloupe, two of which are credited to the vicinity of Naples and two to the island of Malta. The Naples green fleshed is probably the largest and finest of the four, and, strange to say, grows in swampy land. The fruit has large brown seeds and sells in Naples at from forty to sixty cents apiece. In the fall the melons are stored away, and when one is to be ripened it is hung up in a net in the air. In our country, it being too cold, the fruit can be ripened in a room where it is not exposed to the frost. In Naples this variety can be kept from Christmas to Easter, and is said by foreign visitors to be a fine melon.

All the winter melons are long, oval, of a green color, with no network, or merely a trace of it, and weigh from three to four pounds. The Naples varieties are either green fleshed or white fleshed, and the Malta kinds are red fleshed or greenish white. The latter is sometimes known as the Spanish winter melon, and has recently been imported into New York from Cadiz, in Spain. As these melons grow near Naples, in the island of Malta, in the south of France and in Spain, there is no reason why they should not be grown in our Southern States and in California. We have introduced the Japanese plum and persimmon. Why not the winter cantaloupe? Damman & Company, of Portici, near Naples, can furnish experimenters with the two Naples varieties, and the Malta kinds can be had of Vilmorin-Andrieux et Cie., of Paris. Any good seedsman will import them for customers. This new industry is worth trying in Georgia, Florida, Louisiana and Southern California. ROBERT P. HARRIS.

Philadelphia, Pa.

[In Bulletin 95 of the Cornell Experiment Station, on growing melons in winter, one section is devoted to winter melons for field cultivation. These interesting melons, the Cucumis Melo, var. inodorus of Naudin, are little known here, although their long keeping qualities make it possible to send them across the Atlantic, and there has been considerable importation of the fruit here this year. These mostly belong to the variety known as the White Antibes, a large, hard-shelled, bright green, egg-shaped and very long-keeping melon, which has the characteristic odor of the muskmelon, and when properly ripened a good flavor. It belongs to the type which has a soft interior and loose seeds like ordinary melons. Another type, including the winter pineapple, or the green-fleshed Maltese melon of the French, has a solid interior like a cucumber, with the seeds embedded firmly in the structure of the fruit. For field cultivation the winter melons require a long season, and should be picked just before frost and before they have become edible.—ED.]—Garden and Forest.

THE SUN'S HEAT.

THE Persian recognizes in the sun not only the great sources of light and warmth, but even of life itself, and the advances of modern science ever tend to bring before us with more and more significance the surpassing glory with which Milton tells us the sun is crowned, and the prodigality with which it pours forth its radiant treasures.

An intelligent gardener once reasoned that the sun could not be a hot glowing body. He said:

"If the sun were a source of heat, then the closer you approach the sun the warmer you would find yourself. But this is not the case, for when you are climbing up a mountain you are approaching nearer to the sun all the time, but, as everybody knows, instead of feeling hotter and hotter as you ascend, you are becoming steadily colder and colder. In fact, when you reach a certain height, you will find yourself surrounded by perpetual ice and snow, and you may not improbably be frozen to death when you have got as near to the sun as you can; therefore, it is all nonsense to tell me the sun is a scorching hot fire."

I asked him wherein lies the advantage of putting his tender plants into his greenhouse in November. How does that preserve them through the winter? How is it that even without artificial heat the mere shelter of the glass will often protect plants from frost? I explained to him that the glass acts as a veritable trap for the sunbeams; it lets them pass in, but it will not let them escape. The temperature within the greenhouse is consequently raised, and thus the necessary warmth is maintained. The dwellers on this earth live in what is equivalent, in this respect, to a greenhouse. There is a copious atmosphere above our heads, and that atmosphere extends to us the same protection which the glass does to the plants in the greenhouse. The air lets the sunbeams through to the earth's surface and then keeps their heat down here to make us comfortable. When you climb to the top of a high mountain, you pass through a large part of the air. This is the reason why you feel warmer on the surface of the earth than you do on the top of a high mountain. If, however, it were possible to go very much closer to the sun; if, for example, the earth were to approach within half its present distance, it is certain that the heat would be so intense that all life would be immediately scorched away.

The earth on which we stand is no doubt a mighty globe, measuring as it does 8,000 miles in diameter; yet if the earth be represented by a grain of mustard seed, then on the same scale the sun should be represented by a cocoanut. Perhaps, however, a more impressive conception of the dimensions of the great orb of day may be obtained in this way. Think of the moon, the queen of the night, which circles monthly around our heavens, pursuing, as she does, a majestic track at a distance of 240,000 miles from the earth. Yet the sun is so vast that if it were a hollow ball, and if the earth were placed at the center of that ball, the moon could revolve in the orbit which it now follows, and still be entirely inclosed within the sun's interior.

For every acre on the surface of our globe there are more than 10,000 acres on the surface of the great luminary. Every portion of this illimitable desert of flame is pouring forth torrents of heat. It has indeed been estimated that if the heat which is incessantly flowing through any single square foot of the sun's exterior could be applied under the boilers of an Atlantic liner, it would produce steam enough for an entire record breaking voyage from Ireland to America. It would seem very presumptuous for us to assume that the great sun has come into existence solely for the benefit of poor humanity. The heat and light daily lavished by that orb of incomparable splendor would suffice to warm and illuminate, quite as efficiently as the earth is warmed and lighted, more than two thousand million globes each as large as the earth.

What should we think of the prudence of a man who, having been endowed with a splendid fortune of not less than $20 000,000, spent one cent of that vast sum usefully and dissipated every other cent and every other dollar of his gigantic wealth in mere aimless extravagance? This would, however, appear to be the way in which the sun manages its affairs, if we are to suppose that all the solar heat is wasted save that minute fraction which is received by the earth. Out of every $20,000,000 worth of heat issuing from the glorious orb of day, we on this earth barely secure the value of one single cent, and all but that insignificant trifle seems to be utterly squandered. We may say it certainly is squandered so far as humanity is concerned. No doubt there are certain other planets besides the earth and they will receive quantities of heat to the extent of a few cents more. It must, however, be said that the stupendous volume of solar radiation passes off substantially untaxed into space, and what may there become of it science is unable to tell.

And now for the great question as to how the supply of heat is sustained so as to permit the orb of day to continue in its career of such unparalleled prodigality. Every child knows that the fire on the domestic hearth will go out unless the necessary supplies of wood and coal can be duly provided. The workman knows that the devouring blast furnace requires to be stoked incessantly with fresh fuel. How, then, comes it that a furnace, so much more stupendous than any terrestrial furnace, can continue to pour forth in perennial abundance its amazing stores of heat without being nourished by continual supplies of some kind? Prof. Langley, who has done so much to extend our knowledge of the great orb of heaven, has suggested a method of illustrating the quantity of fuel which would be required, if indeed it were by successive additions of fuel that the sun's heat had to be sustained.

Suppose that we extracted from the earth every ton of coal it possesses in every island and in every continent, and that this vast store of fuel, which is adequate to supply the wants of this earth for centuries, were to be accumulated in one stupendous pile and that an army of stokers were employed to throw this coal into the great solar furnace. How long, think you, would so gigantic a mass of fuel maintain the sun's expenditure at its present rate? I am but uttering a deliberate scientific fact when I say that a conflagration which destroyed every particle of coal contained in this earth would not generate so much heat as the sun lavishes abroad to ungrateful space in the tenth part of every single second. During the few minutes that the reader has been occupied over these lines a quantity of heat which is many thousands of times as great as the heat which could be produced by the ignition of all the coal in every coal pit in the globe has been dispersed and totally lost to the sun.

As the sun shines to-day on the earth, so it shone yesterday; so it shone in the earliest dawn of history; so it shone during those still remoter periods when great animals flourished which have now vanished forever, and during that remarkable period in earth's history when the great coal forests flourished; so it shone in those remote ages many millions of years ago when life began to dawn on an earth which was still young. There is every reason to believe that throughout these illimitable periods which the imagination strives in vain to realize, the sun has dispensed its radiant treasures of light and warmth with just the same prodigality as that which now characterizes it.

We all know the consequences of wanton extravagance; and the expenditure of heat by the sun is the most magnificent extravagance of which human knowledge gives us any conception. How have the consequences of such awful prodigality been hitherto averted? How is it that the sun is still able to draw on its

heat reserves from century to century, ever squandering 2,000,000,000 times as much heat as that which genially warms our temperate regions, and draws forth the exuberant vegetation of the tropics, or which rages in the Desert of Sahara? This is indeed a problem.

It was Helmholtz who discovered that the continual maintenance of the sun's temperature is due to the fact that the sun is neither solid nor liquid, but is to a great extent gaseous. His theory of the subject has gained universal acceptance. Nature has not one law for the rich and another for the poor. The sun is shedding forth heat, and therefore, affirms this law, the sun must be shrinking in size. We have learned the rate at which this contraction proceeds, for among the many triumphs which mathematicians have accomplished must be reckoned that of having put a pair of calipers on the sun so as to measure its diameter. We thus find that the width of the great luminary is ten inches smaller to-day than it was yesterday. Year in and year out the glorious orb of heaven is steadily diminishing at the same rate. For hundreds of years, aye, for hundreds of thousands of years, this incessant shrinking has gone on at about the same rate as it goes on at present. For hundreds of years, aye, for hundreds of thousands of years, the shrinking still will go on. As a sponge exudes moisture by continuous squeezing, so the sun pours forth heat by continuous shrinking. So long as the sun remains practically gaseous, so long will the great luminary continue to shrink, and thus continue its gracious beneficence. Hence it is that, for incalculable ages yet to come, the sun will pour forth its unspeakable benefits; and thence it is that for a period, compared with which the time of man upon this earth is but a day, summer and winter, heat and cold, seedtime and harvest, in their due succession, will never be wanting to this earth.—Sir Robert Ball in N. Y. Sun.

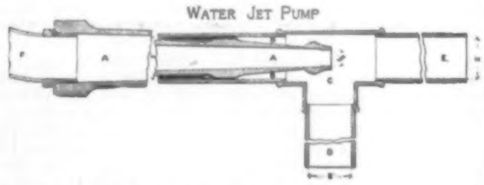
HYDRAULIC EJECTOR.*

A VERY convenient and useful device is the hydraulic ejector or water jet pump, and as it is a contrivance for pumping water which is seldom used I will describe its construction. Since you are all familiar with the steam jet pump, I will say that the principle of the two are exactly the same, and they operate in the same way, with the single exception that in one the jet of steam, and in the other the jet of water, produces the vacuum.

On the construction of sewers during the winter of 1893-94 we used two of these pumps, which we constructed ourselves as follows:

A is an ordinary fire hose nozzle of about ¾ of an inch discharge. This nozzle is firmly leaded into a piece of two inch gas pipe, B, on the end of which is a tee, C, in such a manner as to bring the end of the nozzle nearly over the center of the stem of the tee. D is the suction pipe, 2 inches in diameter. This may be either a piece of pipe or suction hose. E is a 2 inch discharge pipe. This may run for some distance, or

WATER JET PUMP



it may be short and have a piece of hose screwed on to the end of it. F is the fire hose leading from the hydrant, and brings the water to do the pumping.

On the work of which I spoke we used two of these jets, doing away with a clumsy vertical, six inch centrifugal pump which we had been using. Of course the quantity of water was not so great as to require the full capacity of the six inch pump, but there was so much that both a hand pump and a Nye steam pump two and one-half inch discharge failed to lower it sufficiently for work to be done. The sewer being built was an egg-shaped brick sewer 4 × 6 feet, and invert blocks were used for the bottom. The trench was 26 feet deep. Thinking it impossible to raise the water out of the trench, the following method of doing the work was adopted. The pump was made substantially as has already been described, with a suction pipe about ten inches long and the discharge pipe twenty-four feet long. Two of the pumps were used simultaneously. The discharge pipes were placed on the bottom of the completed sewer, with suction just at the end of the sewer. After the pumps were started the inverts for the next bottom were laid down, leaving a place for one block where the suction pipe interfered. After the inverts for a 20 foot bottom were in place the pumps were moved ahead, the missing invert block put in place, and the work of laying brick begun. The discharge pipes lay on top of the inverts and the workmen walking over them did not interfere with them in the least. The working of this water jet was very satisfactory, as the water could be pumped down lower than with the steam pump and it was practically no trouble to move it. The height to which water can be lifted with this pump depends upon the pressure of the water flowing into the nozzle. It requires about eighty pounds pressure to raise it twenty-five feet. Experiments made at Providence, R. I., show that the amount of water required to operate this pump is from four to twenty-nine per cent. more than the water pumped by it. Thus the cost per M gallons of water pumped will exceed by this amount the cost per million gallons pumped at the station. Of course the probability is that such a pump could only be used in a city which owned its own water works. Although it may not be the most economical kind of a pump, its first cost is very low, and it is certainly convenient for repair work, pumping out cellars, back water from sewers which have become clogged, etc.

ORIGINALLY there were no seats in the great cathedrals and mediæval churches. Worshipers stood or knelt. The first innovation was the introduction of small pieces of cloth to keep the feet or knees from contact with the cold stone floors.

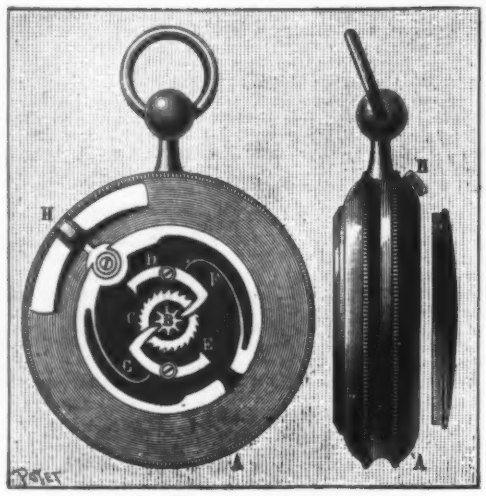
* A. W. Gates, Illinois Society of Engineers.

A NEW KEYLESS WATCH.

MR. REBELLO, of Amparo, Brazil, has recently patented a watch that presents a very original and simple winding and setting arrangement. Externally, it scarcely differs from an ordinary watch, except in the milled disk of the bottom and the glass that protects the face. The mechanism is all located in the bottom of the case. When it is desired to wind the chronometer, the latter is taken in the left hand and the milled disk of the bottom is maneuvered with the right.

In order to set it, the button that projects from the side of the case is slightly displaced and the same movement is effected as before.

The accompanying figure gives the external aspect of the watch and also explains the mechanism. In the hollow of the case, A, are seen two concentric ratchet wheels, B and C. The former of these communicates directly with the hands. The ratchet wheel, C, on



THE REBELLO KEYLESS WATCH.

the contrary, carries beneath it a pinion that meshes with the toothed wheel of the winding barrel. These two wheels are independent of the case, A, as also are the two double clicks, D and E, which are capable of engaging with the teeth of B through their long tooth, and with the teeth of C through their short one. The springs, F and G, are capable of bearing upon one or the other side of the clicks, D and E. When they bear upon the sides carrying the long teeth a gearing occurs with the ratchet wheel, B. When they bear upon the sides terminating in short teeth, a gearing occurs with the ratchet wheel, C. The piece H, which is capable of sliding to a slight degree in its recess, carries a disk to which the two springs are fixed, and when it is shifted from left to right or vice versa, one or the other of the gearings may be effected.

Let us take the case represented in the figure, and in which the gearing is effected through the pinion, B, of the hands. It is evident that upon revolving the bottom disk to the right or left the hands will be made to turn to the right or left. In the opposite case, upon giving the disk an alternating motion, like that of an ordinary remontoir, the barrel will be wound up every time that a revolution is made from right to left.

This system is very simple and not subject to get out of order, because the number of the parts is very limited, and the gearings are effected directly.—La Nature.

IMPROVED SHAPING MACHINE.

WE give an illustration of a 16 inch shaping machine, constructed by Messrs. Thomas Shanks & Company, Johnstone, Scotland. Among other points of novelty we may point out that the variation of driving is by double purchase gear, and that the hand wheel is in direct command of the tool slide. The tool box is fitted with the new relief box, and the tool may be ground well back or in front without losing its clearance action on the return. The feed and quick traverse is worked from the front in either direction. The maximum stroke is 16 inches.—Engineering.

THE ELECTRICITY WORKS OF THE GREAT NORTHERN RAILWAY COMPANY, AT HOLLOWAY, N.

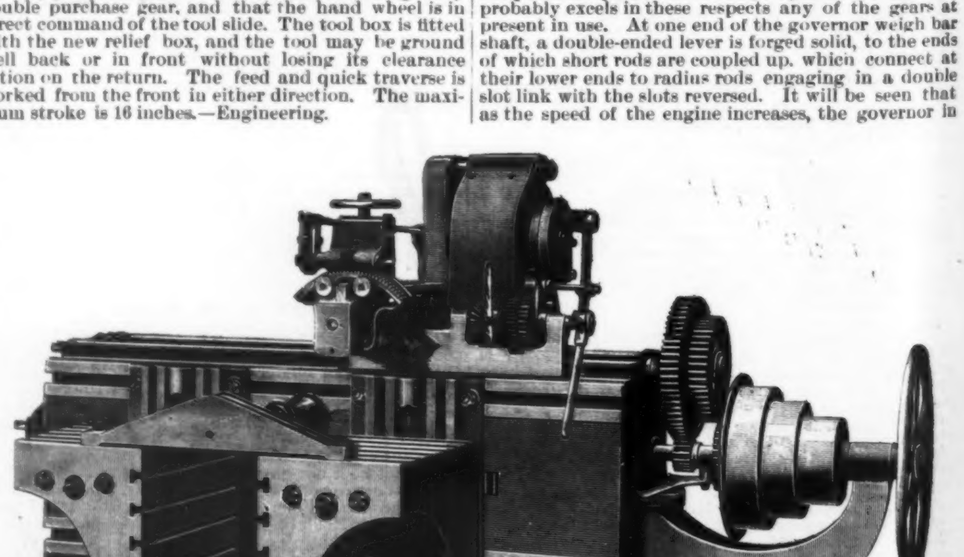
A RECENT number of the Engineer, London, contains a full account of these extensive works. We give extracts and illustrations therefrom descriptive of the generating plant, which may be divided into that which supplies the arc lighting by means of direct current and that which supplies the glow lamp lighting by means of alternating current.

The former plant consists of five steam engines of 120 indicated horse power, each of which drives two Brush generators by means of five ropes to each dynamo. The latter plant consists of three engines, each of 230 indicated horse power, and driving a large Mordey-Victoria dynamo by means of eight ropes, and two 120 indicated horse power engines similar to those alluded to above, and also driving Mordey-Victoria alternators; there are also two small inverted vertical engines of the open type, by Messrs. Browett & Lindley, of Manchester, each driving an exciter. For the alternate current machines one exciter is sufficient to excite all the machines. The whole of the engines, with the exception of the two for the exciters, were built by Messrs. John Fowler & Company, of Leeds, and their construction offers many points of interest.

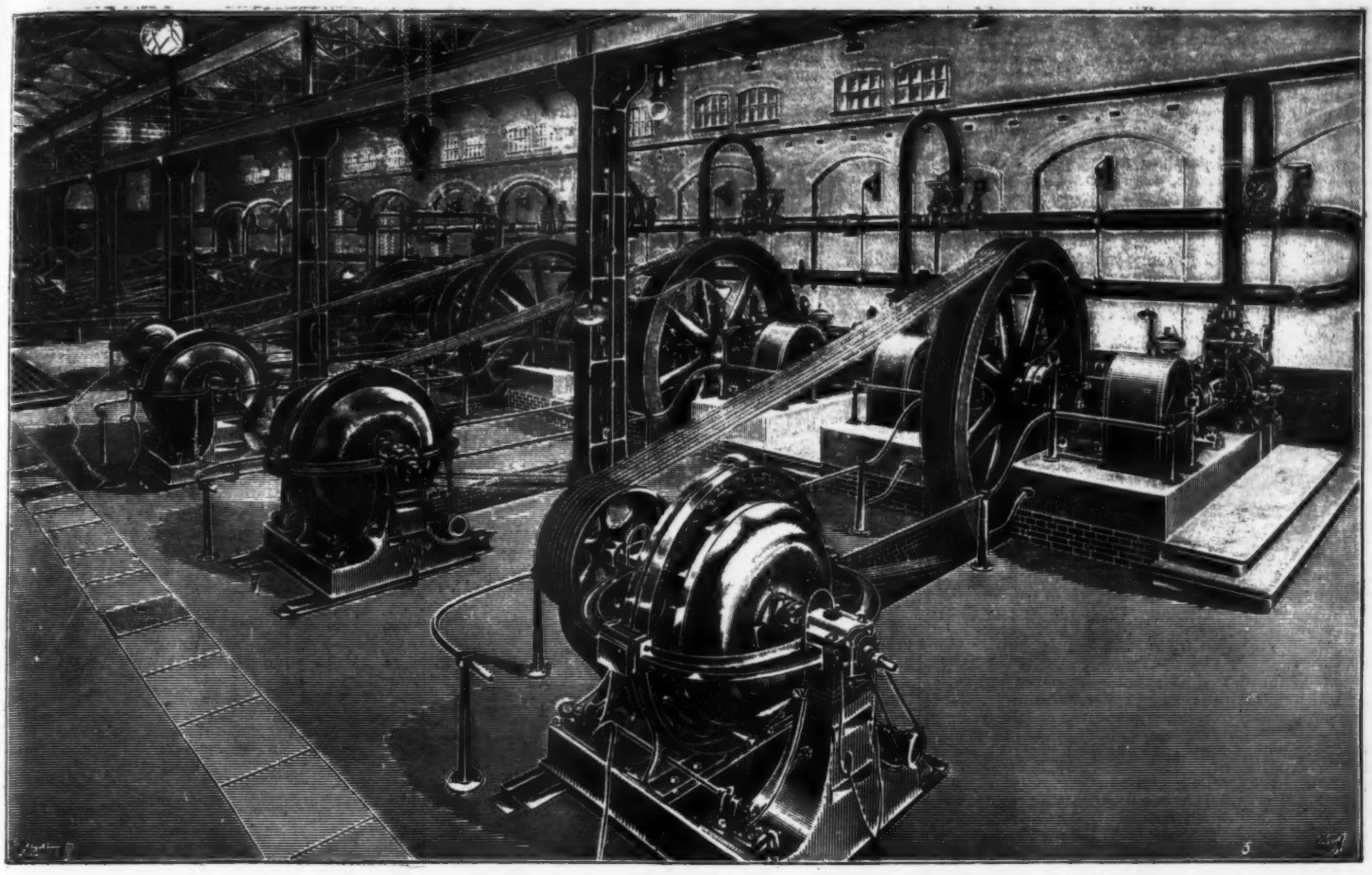
All the engines have the Corliss type of bed plate, and, with a single exception, are fitted with ordinary slide valves, great attention having been paid to the governing. Automatic expansion gear is supplied, and the governors are of a powerful vertical high speed type, controlling the position of the cut-off by means of the ordinary link, and arranged to regulate the speed within 2 per cent. of the normal. The engine to which we have alluded as an exception is fitted with a special new type of valve motion, and was specially designed and manufactured for the work. The particular feature to which attention should be directed is the new form of Corliss valves and gear—Marshall & Wigram's patent. These valves have now been working for some considerable time, and have given great satisfaction, especially as regards good governing and high economy.

A description of this engine will suffice for all. It is of the compound Corliss high pressure non-condensing type, having steam jacketed cylinders side by side. The cranks are at right angles, and it is designed to give off easily 200 indicated horse power at 100 revolutions per minute. The boiler pressure is 125 lb. per square inch, and the dimensions of the cylinders are: High pressure, 15½ in. diameter; low pressure, 25 in. by 30 in. stroke. The high pressure cylinder takes its steam at the top, and exhausts at the bottom into a steam jacketed receiver, and it is fitted with circular valves which are placed in the front and back covers. The position of these valves is as close as possible to the ends of the cylinder, in order that the clearance volumes may be kept to the lowest possible limit. In this case the clearance amounts to a fraction over one per cent.

The main valves are worked from the main eccentric in the usual manner by rods and levers, and have steam and exhaust ports provided in them in a similar way to ordinary flat slide valves, and are in communication with the expansion valves, which are placed in the interior and actuated by the expansion eccentric through levers keyed on the ends of the expansion spindles, which pass through the hollow spindles of the main valves. The cut-off is controlled automatically by a specially designed Marshall governor, which has been found to give most perfect results under trials extending over some three or four years. In some cases the governor has been arranged to work at a variation of ¼ per cent. from no load to full load without any signs of hunting, and this without the use of a dashpot, with its retarding influences. Extensive experience with this governor upon large engines supplied to electricity works, where it is absolutely necessary that the engines should be run regularly in parallel, has also proved it to be all that need be desired. The principle of the gear above referred to may be briefly described as positive in its action, direct driven, and without any intermediate springs or dashpots. We have ourselves witnessed the action of this gear and found it to be exceedingly quick, and at the same time most simple in its details, and we are tempted to say that it not only equals, but in effect probably excels in these respects any of the gears at present in use. At one end of the governor weigh bar shaft, a double-ended lever is forged solid, to the ends of which short rods are coupled up, which connect at their lower ends to radius rods engaging in a double slot link with the slots reversed. It will be seen that as the speed of the engine increases, the governor in



IMPROVED SIXTEEN INCH SHAPING MACHINE.



MORDEY ALTERNATORS, HOLLOWAY ELECTRIC LIGHT WORKS.

rising actuates the double-ended lever, depressing the end which is connected—through the radius rod—to the eccentric rod, thus moving the die lower down in the link, thereby giving the radius rod a longer leverage and causing a shorter travel on the original position in the slot link, at the same time a corresponding motion is given to the other radius rod—which is connected to the valve rod—through the opposite end of the double lever being raised and bringing up with it the die in the other slot link, which is keyed on to the same spindle as the link which takes the eccentric rod, thus giving shorter leverage, hence shorter travel; this, with the already reduced travel on the other link caused by the increased leverage of the eccentric rod, gives an exceedingly quick cut-off.

By this arrangement of levers and links the rods and dies balance each other, reducing the friction on the governor, and the travel of the governor lifting lever is shortened by one-half as compared with link gear of the ordinary type, thus giving it increased sensitiveness and power. The principal feature of this gear, as we have said, is its perfect simplicity and trustworthiness, there being small chance of its getting out of order. All the working parts have adjustable

ENGINE AND DYNAMO ROOM, HOLLOWAY ELECTRIC LIGHT STATION.

brasses that can readily be taken up by any ordinary fitter. The low pressure cylinder receives its steam from the jacketed receiver before mentioned, and is fitted with slide valves of the Meyer type, with expansion gear adjustable by hand.

We subjoin a few particulars of a series of tests taken on February 21, 1895, showing the regular running and performance of this engine under varying loads during a full working day of over eight hours continuously. In testing this engine, a sensitive speed recorder of special construction was attached to the crank shaft, and from diagrams taken by this instrument, it was found that when the full load of over 200 indicated horse power was attained, the maximum variation from the engine's running light and dynamo unexcited was one per cent., and when the full load of 200 horse power was suddenly switched off, the change in speed was only just perceptible on the tachometer of the dynamo, the pointer of which settled instantly, the recording diagram showing also the exact conditions. This engine is in all respects, excepting the high pressure cylinder and valve gear, a duplicate of the other two 230 indicated horse power and the seven 120 indicated horse power engines supplied to this station.

ELECTRIFICATION AND DISELECTRIFICATION OF AIR AND OTHER GASES.*

§ 1. EXPERIMENTS were made for the purpose of finding an approximation to the amount of electrification communicated to air by one or more electrified needle points. The apparatus consisted of a metallic can 48 cms. high and 21 cms. in diameter, supported by paraffin blocks, and connected to one pair of quadrants of a quadrant electrometer. It had a hole at the top to admit the electrifying wire, which was 5·31 meters long, hanging vertically within a metallic guard tube. This guard tube was always metallically connected to the other pair of quadrants of the electrometer and to its case, and to a metallic screen surrounding it. This prevented any external influences from sensibly affecting the electrometer, such as the working of the electric machine which stood on a shelf 5 meters above it.

§ 2. The experiment is conducted as follows:

One terminal of an electric machine is connected with the guard tube and the other with the electrifying wire, which is let down so that the needle is in the center of the can. The can is temporarily connected to the case of the electrometer. The electric machine is then worked for some minutes, so as to electrify the air in the can. As soon as the machine is stopped the electrifying wire is lifted clear out of the can. The can and the quadrants in metallic connection with it are disconnected from the case of the electrometer, and the electrified air is very rapidly drawn away from the can by a blowpipe bellows arranged to suck. This releases the opposite kind of electricity from the inside of the can, and allows it to place itself in equilibrium on the outside of the can and on the insulated quadrants of the electrometer in metallic connection with it.

§ 3. We tried different lengths of time of electrification and different numbers of needles and tinsel, but we found that one needle and four minutes of electrification gave nearly maximum effect. The greatest deflection observed was 936 scale divisions. To find, from this reading, the electric density of the air in the can, we took a metallic disk, of 2 cms. radius, attached to a long varnished glass rod, and placed it at a distance of 1·45 cm. from another and larger metallic disk. This small air condenser was charged from the electric light conductors in the laboratory to a difference of potential amounting to 100 volts. The insulated disk thus charged was removed and laid upon the roof of the large insulated can. This addition to the metal in connection with it does not sensibly influence its electrostatic capacity. The deflection observed was 122 scale divisions. The capacity of the condenser is approximately $\frac{\pi \times 2^2}{4\pi \times 1{\cdot}45} = \frac{1}{1{\cdot}45}$. The quantity of electricity with which it was charged was $\frac{1}{1{\cdot}45} \times \frac{100}{300} = \frac{1}{4{\cdot}35}$ electrostatic unit. Hence the quantity to give 936 scale divisions was $\frac{1}{4{\cdot}35} \times \frac{936}{122} = 1{\cdot}7637$.

The bellows was worked vigorously for two and a half minutes, and in that time all the electrified air would be exhausted. The capacity of the can was 16,632 cubic centimeters, which gives for the quantity of electricity per cubic centimeter, $\frac{1{\cdot}7637}{16{,}632} = 1{\cdot}06 \times 10^{-4}$. The electrification of the air in this case was positive; it was about as great as the greatest we got, whether positive or negative, in common air when we electrified it by discharge from needle points. This is about four times the electric density which we roughly estimated as about the greatest given to the air in the inside of a large metal vat, electrified by a needle point and then left to itself, and tested by the potential of a water dropper with its nozzle in the center of the vat, in experiments made two years ago and described in a communication to the Royal Society in May, 1894.†

§ 4. In subsequent experiments, electrifying common air in a large gasholder over water by an insulated gas flame burning within it with a wire in the interior of the flame kept electrified by an electric machine to about 6,000 volts, whether positively or negatively, we found as much as $1{\cdot}5 \times 10^{-4}$ for the electric density of the air. Electrifying carbonic acid in the same gasholder, whether positively or negatively by needle points, we obtained an electric density of $2{\cdot}2 \times 10^{-4}$.

§ 5. We found about the same electric density ($2{\cdot}2 \times 10^{-4}$) of negative electricity in carbonic acid gas drawn from an iron cylinder lying horizontally, and allowed to pass by a U-tube into the gasholder without bubbling through the water. This electrification was due probably not to carbonic acid gas rushing through the stopcock of the cylinder, but to bubbling from the liquid carbonic acid in its interior, or to the formation of carbonic acid snow in the passages and its subsequent evaporation. When carbonic acid gas was drawn slowly from the liquid carbonic acid in the iron cylinder placed upright, and allowed to pass, without bubbling, through the U-tube into the gasholder over water, no electrification was found in the gas unless electricity was communicated to it from needle points.

§ 6. The electrifications of air and carbonic acid described in §§ 4 and 5 were tested, and their electric densities measured by drawing by an air pump a measured quantity of the gas* from the gasholder through an

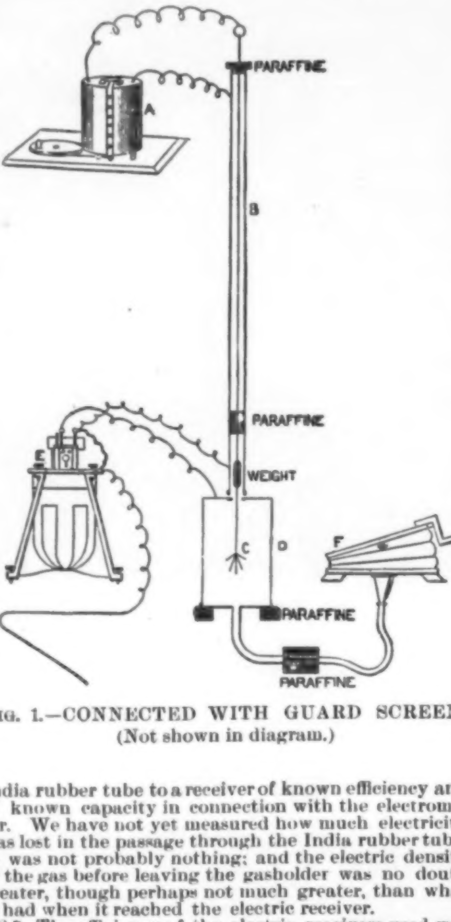


FIG. 1.—CONNECTED WITH GUARD SCREEN. (Not shown in diagram.)

India rubber tube to a receiver of known efficiency and of known capacity in connection with the electrometer. We have not yet measured how much electricity was lost in the passage through the India rubber tube. It was not probably nothing; and the electric density of the gas before leaving the gasholder was no doubt greater, though perhaps not much greater, than what it had when it reached the electric receiver.

§ 7. The efficiency of the electric receivers used was approximately determined by putting two of them in series, with a paraffin tunnel between them, and measuring by means of two quadrant electrometers the quantity of electricity which each took from a measured quantity of air drawn through them. By performing this experiment several times, with the order of the two receivers alternately reversed, we had data for calculating the proportion of the electricity taken by each receiver from the air entering it, on the assumption that the proportion taken by each receiver was the same in each case. This assumption was approximately justified by the results.

§ 8. Thus we found for the efficiencies of two different receivers respectively 0·77 and 0·31 with air electrified positively or negatively by needle points; and 0·82 and 0·42 with carbonic acid gas electrified negatively by being drawn from an iron cylinder placed on its side. Each of these receivers consisted of block tin pipe, 4 cms. long and 1 cm. diameter, with five plugs of cotton wool kept in position by six disks of fine wire gauze. The great difference in their efficiency was no doubt due to the quantities of cotton wool being different, or differently compressed in the two.

§ 9. We have commenced, and we hope to continue, an investigation of the efficiency of electric receivers of

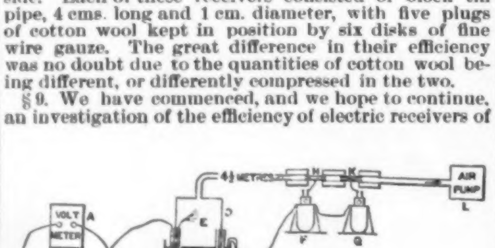


FIG. 2.

various kinds, such as block tin, brass, and platinum tubes from 2 to 4 cms. long, and from 1 mm. to 1 cm. internal diameter, all of smooth bore and without any cotton wool or wire gauze filters in them; also a polished metal solid, insulated within a paraffin tunnel. This investigation, made with various quantities of air drawn through per second, has already given us some interesting and surprising results, which we hope to describe after we have learned more by farther experimenting.

§ 10. In addition to our experiments on electric filters we have made many other experiments to find other means for the diselectrification of air. It might be supposed that drawing air in bubbles through water would be very effective for this purpose, but we find that this is far from being the case. We had previously found that non electrified air drawn in bubbles through pure water becomes negatively electrified, and through salt water positively. We now find that positively electrified air drawn through pure water, and negatively electrified air through salt water, has its electrification diminished but not annulled, if the primitive electrification is sufficiently strong. Negatively electrified air drawn in bubbles through pure water, and positively electrified air drawn through salt water, has its electrification augmented.

§ 11. To test the effects of heat we drew air through combustion tubes of German glass about 180 cms. long, and 2½ or 1½ cms. bore, the heat being applied externally to about 120 cms. of the length. We found that, when the temperature was raised to nearly a dull red heat, air, whether positively or negatively electrified, lost little or nothing of its electrification by being drawn through the tube. When the temperature was raised to a dull red heat, and to a bright red, high enough to soften the glass, losses up to as much as four-fifths of the whole electrification were sometimes observed, but never complete diselectrification. The results, however, were very irregular. Non-electrified air never became sensibly electrified by being drawn through the hot glass tubes in our experiments, but it gained strong positive electrification when pieces of copper foil, and negative electrification when pieces of carbon, were placed in the tube, and when the temperature was sufficient to powerfully oxidize the copper or to burn away the charcoal.

§ 12. Through the kindness of Mr. E. Matthey, we have been able to experiment with a platinum tube 1 meter long and 1 millimeter bore. It was heated either by a gas flame or an electric current. When the tube was cold, and non-electrified air drawn through it, we found no signs of electrification by our receiver and electrometer. But when the tube was made red or white hot, either by gas burners applied externally or by an electric current through the metal of the tube, the previously non-electrified air drawn through it was found to be electrified strongly positive. To get complete command of the temperature we passed a measured electric current through 20 centimeters of the platinum tube. On increasing the current till the tube began to be at a scarcely visible dull red heat, we found very little electrification of the air. When the tube was a little warmer, so as to be quite visibly red hot, large electrification became manifest. Thus 60 strokes of the air pump gave 45 scale divisions on the electrometer when the tube was dull red, and 395 scale divisions (7 volts) when it was a bright red (produced by a current of 36 amperes). With stronger currents, raising the tube to white hot temperature, the electrification seemed to be considerably less.

THE PHOTOGRAPHIC DECORATION OF GLASS AND PORCELAIN.

THE decoration of glass and porcelain by photographic means is readily attainable by certain processes, but to secure vitrified photographic images involves difficult and somewhat intricate processes. Where it is simply desired to make transparencies on glass for window decoration, or pictures on opal for framing, the means are ready to hand, as prepared sensitive plates are obtainable commercially in various sizes, and clear instructions being inclosed, no trouble should be experienced in getting results. Such plates will not, however, stand cleaning or washing, so that they soon either become dirty, and are damaged in attempts to clean them, or they fade and discolor. A more permanent and rather easy way of transferring a photographic image to porcelain or opal is to varnish the plate with copal, and then squeegee, face down upon it, a toned and fixed print on the usual sensitized albumenized paper while wet. It is allowed to dry for about four hours, and then the back of the paper is moistened with a damp sponge, when it can be peeled off, the albumen adhering to the varnish. This should then receive a protecting coat of varnish.

Another method is the carbon process. Carbon tissue, a paper coated with gelatine mixed with pigments of various colors, may be purchased ready sensitized. It is exposed under a negative soaked in cold water, and then squeegeed to the glass or opal, or porcelain support, which should previously have been coated with a thin sizing of gelatine (1 ounce in 18 ounces of water, with 20 grains of bichromate of potassium dissolved in 2 ounces of water added). The plates, after being coated with this mixture, are allowed to dry in the sun or in a strong light. Development is effected with warm water, the gelatine washing away in proportion to the action of the light, that unacted upon being completely washed out. When dry a very perfect picture is left, and it is permanent so far as the fading action of light is concerned, but still susceptible to damage through moisture.

A very hard waterproof enamel picture can be made on glass, porcelain, or opal by the following process, which has the advantage of not requiring any special appliances. Two ounces of the best gum arabic are dissolved in 10 ounces of water. Ten grains of chromic acid dissolved in a little water are added, and finally 1 ounce of a saturated solution of bichromate of ammonium. When the ingredients are fully dissolved and mixed, stir in as much finely powdered asphaltum as will give the solution a good body. It must be of such thickness that, when flowed on a plate, the grain appears homogeneous, and not in minute particles. The plate should preferably be coated with a whirler. If heat is used in drying, care should be taken not to make the plate hot, or the film will refuse to develop. Exposure is made under a negative as usual, and the printing will be fairly rapid. Development is effected by gently laving with water. Slightly warm water can be used if the development does not easily progress. When the image is clear in all details the plate should be dried, and then placed in an ordinary oven on a bed of sand or plaster of Paris. Heat is gradually applied until the proper tint is reached. The resinous powder known as "dragon's blood" could probably be equally well incorporated with the gum solution so as to give a red picture.

Another simple way of forming a kind of enamel

* Abstract of a paper, by Lord Kelvin, Magnus Maclean, and Alexander Galt, read before Section A of the British Association.

† "On the Electrification of Air," by Lord Kelvin and Magnus Maclean.

* The gasholder was 38 cms. high and 81 cms. in circumference. Ten strokes of the pump raised the water inside to a height of 8·1 cms., so that the volume of air drawn through the receivers in the experiments was 428 cubic centimeters per stroke of the pump. This agrees with the measured effective volume of the two cylinders of the pump.

picture is to prepare a photo-lithographic transfer rather "full" of ink. The ready coated paper for transfers may be purchased, and is sensitized on a bath of bichromate of potassium, 1 in 20. When dried this paper is exposed under a negative or positive in line or in half tone stipple. The next stage is to black the film all over with a thin coat of photo-transfer ink, applied with a velvet or composition roller. On immersing the print in water, and rubbing gently with a sponge, the superfluous ink will wash away. When quite clean the paper is allowed to dry, and is then transferred in the usual lithographic manner by pressure. If the picture is not too large, it may be transferred to porcelain by damping the transfer until slightly tacky, then attaching it to the object which is to receive the image, laying on top a piece of thin card and rubbing the back strongly with a burnisher, taking care that the transfer paper does not slip. Such a transfer having been secured, it should be dusted with resin, and slightly heated to make the resin tacky. Any finely powdered, vitrifiable color mixed with a little flux can then be brushed on with a soft camel's hair brush, and will adhere to the lines. The plate is then placed in a muffle furnace until the color is fused. A porcelain glaze is afterward applied to protect the image and give increased luster.

The production of purely photographic enamels is a more complicated process than any of the foregoing. One method involves the production of a collodion positive, which is transferred to the plaque or other surface, and then fired in a muffle furnace. The result of the firing is to destroy the collodion film and leave the metallic silver image. To secure richness, the image, while on its collodion support, is toned with chlorides of iridium and gold. After firing, the picture is flowed with a porcelain glaze several times until the desired brilliancy is obtained. Such a process requires an intimate photographic knowledge, and especially of that now neglected branch, the collodion processes.

For the worker who is not so advanced the following process would promise better. A solution is made up as follows:

Gum arabic	7 drachms
Grape sugar (glucose)	3 drachms
Bichromate of potash	5 drachms
Water	10 drachms

This solution is filtered and used as soon as possible, as it will not keep more than three days. The plaque, which must necessarily be flat, is flowed with clean water, and the solution poured on so as to drive the water before it. The drying requires considerable heat, such as applied by an oven. With regard to the printing, it must be borne in mind that a positive gives a positive and negative a negative image. The tablet, when thoroughly dry and while still hot, is placed in contact with the positive, which must also be warmed. The printing is exceedingly rapid; in the most brilliant sunshine less than a quarter of a minute. As soon as the tablet is removed from the frame it begins to absorb moisture from the air. It thereby acquires tackiness, so that when powder of any kind is brushed on, the powder adheres in proportion to the action of the light, that is to say, most powder adheres to the shadows and least to the high lights. The powder is kept in motion till the image is fully charged, which should be in about one minute. If the film has become too tacky by development being delayed, the picture will be smudgy. When the image has been fully developed, the superfluous powder is dusted away and the film coated with plain collodion. When this is well set, the tablet is placed in water to allow the gum and bichromate to dissolve out. The film is then dried, and, assuming that the powder employed is of a vitrifiable nature, the tablet is placed in a muffle, and heat applied until the fusing point is reached. A porcelain glaze is afterward applied.—Technical World.

A NEW RUBBER INDUSTRY IN LAGOS, AFRICA.*

(Kickxia africana, Benth.)

IN West Africa it is well known there are numerous plants yielding commercial rubber. The chief of these are species of the Apocynaceous genus Landolphia, consisting of climbing shrubs, with stems 4 to 6 inches in diameter, dividing above into numerous branches, and supporting themselves on neighboring trees. From these, and similar plants, a very important rubber industry was started at the Gold Coast by Sir Alfred Moloney, K.C.M.G., in 1882; and although previous to that year no rubber whatever was exported from that colony, it had attained in 1893 to the annual value of £200,000. This is a remarkable and striking instance of the creation of a new industry by official action, and it deserves to be recorded. In 1882 Sir Alfred Moloney addressed a letter to the Lagos Times (Forestry of West Africa, pp. 83-88) strongly recommending attention to the possibilities of a similar rubber industry in Lagos, and suggesting "the adoption of measures having for their object the addition of one more to the industries of the colony." The result of this was not immediately apparent. But in 1894 the present governor of Lagos, Sir Gilbert T. Carter, K.C.M.G., issued the following notice, as appears from the Report on the Botanic Station for the quarter ending June 30, 1895:

"His excellency the governor desires to notify to the mercantile community of Lagos that he has been able to induce a party of natives from the Gold Coast experienced in rubber collecting to come to Lagos, with a view to the development of this valuable and important industry. The men have already inspected certain districts, which they report to be rich in rubber-producing plants, and it is confidently hoped that Lagos will shortly be able to compete with the sister colony of the Gold Coast in the great export of the product."

Following this came the announcement that a new rubber-yielding plant had been discovered in the colony of Lagos, and that it was a large tree abundantly distributed in the interior forests.

The native name of this rubber tree is Ire, Ireh, or Ereh. The Ire tree is one of the most beautiful trees in the forest. From the ground it grows evenly in bulk and smoothly to the height of 60 to 70 feet. The average thickness of the tree is 12 to 14 inches in diameter. In the rainy season, when the trees are full of milk, a tree well tapped is capable of producing from 10 to 15 pounds of rubber.

The habitat of Kickxia africana was stated in the Icones to be "West Tropical Africa, Bagroo River, and Fernando Po, Mann No. 817, Bonny, Kalbreyer." It is evident that it has very wide distribution, extending from Sierra Leone to the Gold Coast and beyond the mouths of the Niger to the Bight of Biafra. How far it may extend inland it is impossible to say.

In tapping the tree the bark is first cut in a vertical direction from the bottom to the top. This single line is about ⅛ to ⅝ of an inch broad, and deep enough to reach the inner bark. This forms the main groove. On each side of this two series of oblique grooves, about two feet apart, are cut, each running into the main groove. The side grooves are made, beginning at the top, and gradually reaching the base of the tree. All the milk exuding from the lateral grooves will find its way into the main groove and so ultimately reach the bottom, where a vessel is placed to receive it. When sufficient milk has accumulated it is then collected and made into rubber.

The methods adopted for coagulating the milk are at present of two kinds, viz., "the cold process" and "the heat process." The cold process is chiefly practiced by the Fanti men introduced from the Gold Coast. A cavity is excavated in the trunk of a fallen tree so as to form a cistern of the capacity necessary for holding the milk collected during several days. Into this rubber gatherers pour the milk, after straining it, from day to day, until it is quite full. It is then covered with palm leaves and left for twelve to fourteen days and sometimes much longer, depending on the season, until most of the watery portions have either evaporated or sunk into the wood. After being kneaded and pressed together, the rubber thus obtained has a dark brownish color, with the inner portions of a slightly lighter color. Such rubber is known locally as "silk rubber."

The local price is from 10d. to 1s. 2d. per pound.

The heat process is the one generally adopted by the natives of Lagos. This is much simpler in working, as it disposes of all the milk collected at the close of each day. After being strained, the milk is placed in a vessel and boiled. The rubber begins to coagulate almost directly the heat is applied, and after the boiling is over removed in a somewhat sticky condition, owing to being burnt, and of a blackish color. The local price of this rubber is from 9d. to 1s. per pound. It is pointed out that the heat process, though simpler, impairs the quality of the rubber, and is calculated to injure the industry. It is probable that if the heat process were somewhat modified, the results would not be so injurious. An experiment was tried at the Kew Botanic Station to coagulate the milk by heat, but not applied directly to it. The result was much more satisfactory. The rubber came off of a milky white color, and after being pressed it was clean and firm, without being sticky. A sample of this received at Kew was reported upon as worth in London 2s. 4d. per lb.

The history of this new rubber industry in Lagos is full of interest, and illustrates the wonderfully rich resources of the vast forests of West Africa. It shows also very clearly how largely these resources can be developed by judicious and intelligent action on the part of the government.

Should the new Kickxia rubber continue of commercial value, there is no doubt that it will eventually be possible to establish regular plantations, and thus make the industry a permanent one.

M. Smith del. Vincent Brooks Day & Son lith.

KICKXIA AFRICANA, BENTH.

EXPLANATION OF PLATE.

1. Flowering branch (natural size). 2. Bud. 3. Segment of calyx with glands at the base. 4. Corolla, cut open with style and stigma removed. 5. Anther, front view. 6. Pistil with disk (d). 7. A pair of follicles (natural size). 8. Seed. 9. Transverse section of seed (t. testa, a. albumen, c. cavity). Nos. 2 to 6 and 8 and 9 all enlarged.

* Abstracts from the Kew Bulletin, No. 106.

A VISIT TO THE HOLYOKE PAPER MILLS.

AT the recent general meeting of the American Chemical Society a number of members were taken over the works of the Holyoke Paper Company, U. S. A., about which the following interesting particulars were given to the members:

The company use both American and foreign rags. The rags are first dusted in a star-shaped holder, which, by its revolution, allows the rags to fall down from one star point to another, thus driving out the dust, which escapes through the meshes of the sieve-like sides of the holder.

After being dusted the rags are placed upon tables where they are picked over by hand, and buttons, hooks and eyes, pieces of whalebone, rubber, etc., are removed, scythes being used to cut them off when possible. Sometimes valuable articles are found, and these the workers are allowed to keep. This furnishes a strong incentive for the careful examination of the rags. After the first picking over the rags are examined again by another person, and any remaining objectionable articles removed, and the rags are also sorted into different grades. The rags are then passed between closely fitting cogs which tear them into shreds, after which they are chopped into small pieces by an instrument in which the knives revolve in a manner similar to those of a lawn mower. After this the rags are sometimes subjected to another process of dusting by being whipped while in a suitable receptacle.

They are then put into large revolving cylinders and boiled under pressure of thirty-five to fifty pound in milk of lime of about the consistency of cream. After being thus treated sufficiently they are removed, the lime allowed to drain off, and the rags are then put into washing engines, where they are reduced to pulp, a stream of clear spring water flowing in and a stream of dirty water flowing out continuously at the other end of the washing machine.

The rags are reduced to pulp by the scraping action of steel bars, those of one set passing through the narrow spaces between the others and thus drawing out the fiber somewhat like the process of scraping cloth for lint. When the rags have been reduced to pulp and sufficiently washed, a solution of chloride of lime is run in for the purpose of bleaching the pulp. At this stage the flow of water in and out of the vat is checked, as is also the pulp-reducing action of the machine, and the mechanical action is simply such as to keep the bleaching pulp stirred and rotating around in the vat of the machine.

After being bleached the pulp is allowed to flow into draining rooms, i. e., into large receptacles containing a perforated bottom, where it remains from five days to three or four weeks, according to the requirements. The chloride of lime water is there drained off.

The bleached and drained pulp is then put into beating engines, where it is washed with water to remove any remaining chloride of lime, and, if necessary, sodium hyposulphite is added to neutralize the last traces of the chloride. It is here reduced to a very fine fiber. Then it is put into a large tank and pumped on to a paper machine having a large endless piece of wire cloth, which is drawn along and carries with it the fiber thinned with a sufficient amount of water. In this operation the cloth is given a shaking motion, and as the water runs off the fibers are shaken closely together, interlaced more or less, and packed down so

as to cohere into one continuous sheet. The remaining water, so far as possible, is withdrawn from the fiber by a suction pump.

From the wire cloth the paper passes between heavy rollers and upon a sheet of woolen felt. Thence it goes over iron cylinders heated inside with steam. After the paper is thus dried, it is passed through a solution of glue or extract of rawhide. This animal sizing is thus absorbed by the paper, some vegetable sizing having been already introduced into the material in the beating engine. The vegetable sizing is resin. The paper, wet with animal sizing, is hung over poles where it dries slowly. If rapidly dried, the strength of the glue is partly destroyed.

When dried, the paper is calendered. There are two methods of calendering: (1) the American, by which the paper passes between rolls, three of chilled iron and two of paper arranged alternately; (2) the foreign, by which the paper is pressed between two heavy chilled rolls after having been packed in layers between zinc or pasteboard plates.

The best quality of paper is not weighted. No weighting is done at the mills of the Holyoke Paper Company. Whenever weighting is done at all, the weighting—or filling—material is introduced into the heating engines with the pulp.

THE MASSACRES IN ARMENIA.

Armenia and Kurdistan form a part of the Turkish empire in Asia, and the population is about 5,000,000. As a large number of the inhabitants of this district of the Turkish dominions are Christians, conflicts with the Turks have been frequent. In March, 1894, disturbances broke out at Yazgat, through the murder of a Turkish policeman by an Armenian. A series of disturbances occurred in other parts of this country during the year, and Turkish injustice and oppression drove the people to revolt. In one of the earlier disturbances the American Christian College at Marsovan was held by the authorities to be the great instigator of the disturbances. The truth of the matter was merely that, owing to evangelistic work in Armenia, of which the college was the center, the people had naturally aspired to a high degree of religious and educational freedom, and the uprising of the oppressed people was made the excuse for throwing scores of innocent people into prison and for closing the college and burning a part of it. A number of the teachers were arrested and seventeen were sentenced to death upon false and forged evidence. Representations were made to the Sultan by several powers on behalf of the condemned men; the result was that only five were executed.

The massacres have been almost continuous from that time to the present day, and whole districts have been devastated.

It is estimated that 250,000 Armenians, in the ravaged districts, are now in a state of starvation. Minister Terrell expresses an opinion that upward of 10,000 Armenians have been massacred in the thirty days preceding November 12. The powers are bringing great pressure to bear upon the Sultan to put a stop to these atrocities, but, up to the present time, the Sultan's lukewarm efforts at reform have amounted to nothing.

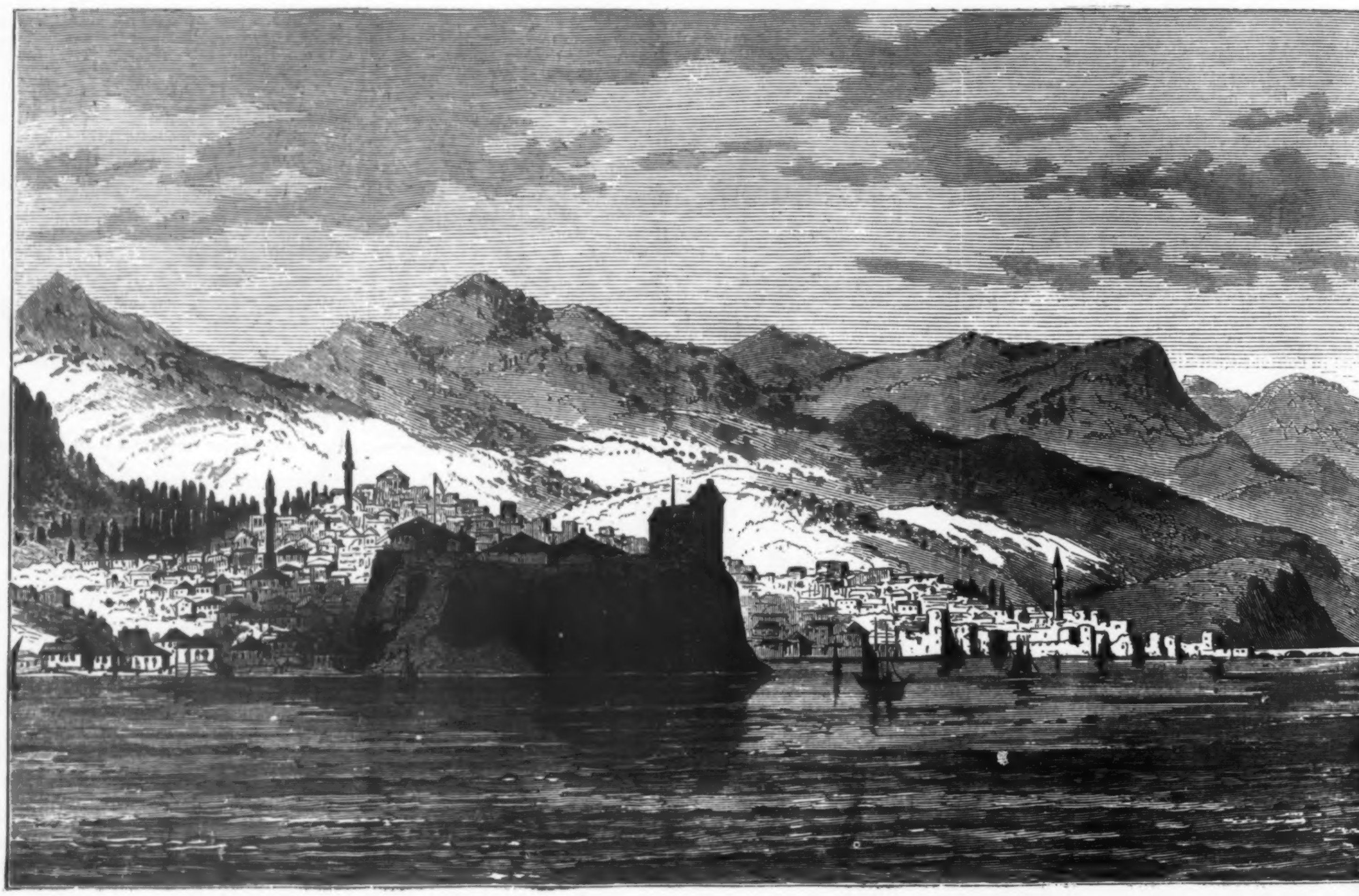
At the Lord Mayor's banquet in the Guildhall, London, on November 9, Prime Minister Salisbury said that if the Sultan did not succeed in stopping the massacres and introducing reforms, "that persistent and constant misgovernment must lead the government which follows it to its doom, and while I readily admit that it is quite possible that the Sultan, if he likes, can govern with justice and can be persuaded that he is not exempt any more than any other potentate from the law that injustice will bring the highest one on earth to ruin. It is not only the necessary action of the law of which I speak on which we may rely, there is the authority of the great powers. Turkey is in one of the most remarkable positions that she has stood for half a century, mainly because the powers resolve that, for the peace of Christendom, it is necessary that she should stand. The danger is that, if the Ottoman empire falls, it would not be merely a danger that threatens its territory, it would be the danger that the fire there lit would spread to other nations, involving all that is most powerful and civilized in Europe in a dangerous conflict."

It is considered that these words of Lord Salisbury are prophetic, and foreshadow the dismemberment of Turkey.

The powers have mobilized a fleet of great strength at the Dardanelles. This fleet is prepared for any emergency which may arise. It is quite possible that the next few weeks will see serious difficulties.

We present an illustration of Trebizond, the seat of some of the Armenian massacres. Trebizond is a city of Asia Minor, situated on the Black Sea, and was an old Greek colony, and has always been a considerable commercial port. Its importance is due to its geographical position, because it commands the point where the chief and most direct trade route from Persia and Central Asia to Europe over the tableland of Armenia descends to the sea. The climate is temperate and favorable for the growth of vegetation, and, unlike that of the inland regions, it is exposed to great extremes of heat in summer and cold in winter. The city occupies a sloping table of land, which falls in steep, rocky precipices on two sides, where two deep valleys, descending from the interior, run parallel at no great distance from one another down to the sea. The city is still inclosed by the Byzantine walls which follow the lines of cliffs and are carried along the sea face. The harbor lies on the eastern side of the promontory, and the neighborhood of this harbor is the liveliest portion of the city, and it is from here that the caravans start for Persia, and at certain periods of the year long trains of camels may be seen arriving here. The estimated population of Trebizond is 33,000.

For our engraving we are indebted to the Illustrated London News.



TREBIZOND, THE SCENE OF THE ARMENIAN MASSACRE.

RECENT ADVANCES IN BACTERIOLOGY, WITH SPECIAL REFERENCE TO FOOD.*

By M. V. Ball, M.D.

Bacteriology is, comparatively, a recent science. Only within the last ten years has it received any special attention, and within this time it has been given a place in the medical colleges and become recognized as an important department of knowledge.

Municipalities are forming laboratories for bacteriological work, and governments are instituting, on a large scale, researches which must eventually be of great service to mankind. It is hardly to be expected that this subject should as yet be the common property of any but those who have made it a special study, and, therefore, a few words as to the nature of bacteria will not be out of place here.

Bacteria—from the Greek, meaning little or minute rods—is a term applied to various forms of organisms, microscopic in size, closely allied to the lower types of fungi and algæ; usually containing no chlorophyl; capable, in many instances, of propelling themselves with swift motion through the liquids in which they are found, and possessing, for this purpose, small cilia or flagella, like other types of microscopic plants.

They are very minute, requiring for their detection powerful lenses. Some idea of their size may be obtained from the statement that in the space of an inch from 15,000 to 20,000 can be placed side by side; but, growing together in large numbers as they do, such aggregations or colonies can readily be seen with the unaided eye, though the individual members of these colonies cannot be recognized.

Bacteria are neither yeasts nor moulds, though possessing some of the characters of both.

The name, "bacteria," is not a good one, since other than rod-shaped organisms are collected under this group. Micrococci are globular or spherical bacteria; bacilli are the rod-shaped bacteria; and spirilli are spiral formed or twisted bacteria. The colonies of one form are not to be distinguished from the others, but under the microscope the difference in shape is readily made out.

Bacteria are quick breeders; they multiply very rapidly. From one or two germs thousands are obtained in the course of a few hours. Some one has made the calculation that a single germ, if uninterrupted in its growth, would fill an ocean with its progeny in five days; but, fortunately, it digs its own grave by the poisons it generates, and so puts a limit to its growth. Some require several days before germination occurs. Two kinds of growth are known: One, in which reproduction is a process of fission or segmentation—one bacterium dividing itself into two, and each of these again subdividing—in reality, a continuation rather than a reproduction. And a second kind, known as sporulation. The germ gives rise to a spore, the spore then takes on a separate existence, and, when the conditions favorable to maturation exist, it gives rise to a new germ.

Both forms of growth are utilized by the same bacterium. Under ordinary conditions it multiplies by fission when a permanent form is advantageous, or, as some think, when the soil is particularly rich, it produces spores. Spores have not been found in all bacteria; those possessing them are very resistant to all physical and chemical agencies, and withstand a high degree of heat without being destroyed.

For the different bacteria different conditions are necessary. Just as different plants require different kinds of soil and temperature, so these minute plants react differently and demand for their growth various surroundings. Some are not at all particular, and flourish on any sort of soil. They are like weeds that grow without attention; others again are as sensitive as hothouse plants, and require very carefully prepared media and a suitably regulated temperature.

* A lecture delivered before the Franklin Institute.—From the Journal.

While some species demand a plentiful supply of oxygen, others grow only when this is excluded. Sunlight is usually destructive; an alkaline medium is better tolerated than a neutral one, and acids are usually harmful. Moisture is necessary to growth.

Bacteria are not only disease producers, they manufacture a host of products beneficial and essential to life. Life itself depends, in a great measure, upon the actions of these minute plants, which transform the complex molecules into their elements and make them fit for assimilation. If we could separate the industrial germs from the pathogenic or disease producers and domesticate the former, while we drive the latter out of existence, life would be more worth the living. This is gradually being attempted. Scientists are pointing out to us the properties of individual varieties and showing us the methods of cultivation; while hygienists and therapeutists are doing all they can to exterminate the destroyers of life; so that we can already see how, in a few years, cholera will be a rare disease, and tuberculosis will no more be counted as the cause of one-fifth of all deaths.

What advances, if any, have been made in recent years as relates to the subject of foods? This is the topic I have been asked to consider: "Bacteria in their relation to food."

First of all, I desire to take up the most important of foods, namely, water. Water is a food, because it is necessary to sustain life, and considered in this sense, air might also be classed as a food. But whether or not we call water a food, there are other reasons sufficient for us to make it a matter for consideration here.

Formerly a good water was one which came up to a certain chemical standard. The amount of chlorides and nitrates was determined, the hardness was computed and the total amount of solids ascertained. If a water did not contain more than one grain of chlorine per gallon, it was deemed potable. To-day, while chemical analysis still has an important place in the examination of water, it must go hand in hand with the biological or bacteriological analysis, and we must know what sort of living organisms inhabit or are to be found in the specimen in question.

In the early days of bacteriology much stress was laid upon the number of bacteria found in a given quantity of water, and water containing more than 500 colonies to the cubic centimeter was deemed unfit for drinking, but now it is not so much the quantity as the quality of the bacteria that is looked for. One typhoid bacillus in a gallon of water is more dangerous than one million ordinary water bacteria; in fact, it would render the water impotable, while the latter would be harmless. Thus, the water analyst of to-day must be a competent bacteriologist as well as chemist; and to be a bacteriologist means a pathologist as well, for, in the investigation of bacteria, animals must be used for experiment, and the nature of the diseases caused by the bacteria must be known to the experimenter.

As in the earlier chemical analyses, the chlorine itself was not considered dangerous, but simply one of the indications of fæcal contamination, so in the bacterial examination, the presence of certain harmless germs may indicate dangerous contaminations. For instance, the presence of the bacilli commonly found in human fæces, which in themselves are non-pathogenic, would, of course, lead one to infer that human sewage had become mixed with the water supply.

The methods for the detection of typhoid bacilli in drinking water leave much to be desired. The examination is often undertaken too late, when the bacilli are no longer present, or have been destroyed by the ordinary water bacteria. Typhoid bacilli do not live long in ordinary drinking water; and yet, if the water be contaminated with them, a whole city or district can become infected in a short time, and when suspicion is directed to the water the germs have disappeared. To a less degree this is likewise true of the cholera spirillum, which acts so quickly and is so deadly, and which usually is spread through the drinking water.

A method lately described, and which promises success, is to take a large quantity of the suspected water (200 cubic centimeters) and add to it 2 grammes of peptone and 2 grammes of chloride of sodium. Place this in the incubating oven, and, if cholera germs are present, they will multiply rapidly, so that they can readily be detected in the course of ten to twelve hours.

Bacteric examinations have been most useful in the testing of water filters, "germ proof" filters, etc. Several filters are now in the market, which claim to be germ proof; that is to say, which are supposed to prevent the passage of bacteria through the very minute pores of the filter. These filters are made of baked clay, infusorial earth, porcelain, etc. As a rule, they can deliver a germless water only for a few days in succession, when, owing to the activity of the bacteria which have collected on the surface of the filter cylinder, the pores are penetrated by the growth, and more bacteria than usual find their way into the water. This, in some cases, can be prevented by a careful cleansing, every few days, of the filter tube. All tubes are not alike, and some afford no protection at all, though they clarify the water by keeping out the grosser particles of dirt.

Filters are best tested by adding to the water, before filtration, some well known bacterium (usually the red pigment forming and rapid growing Bacillus prodigiosus) making cultures before and then after filtration. If under suitable precautions the germ is found present in the filtered water, the filter is imperfect. In the testing of large filtering plants, where it is not expected that the water will be perfectly free from germs, quantitative methods must be used in order to tell what percentage of bacteria is left behind.

These large filtering plants are in use in several cities, and, it seems to me, they are of doubtful value only. It is true the water is more pleasing to the eye, and, for toilet and laundry purposes, more valuable; but if the water is contaminated with disease germs, there is no surety that they will be among the 50 per cent. filtered out. They are just as liable to pass through as the others, and such a water is not safe. From the sanitary point of view, filtering plants are only valuable when the water is uncontaminated by human sewage; and to erect such a plant in our city, without paying any attention to the source of our water supply, and even allowing it to be polluted along its whole course, will hardly reduce the death rate, though it may add to the æsthetic quality of the water.

On an average, 500 deaths occur every year in this city from typhoid fever. This means at least 6,000 cases. From an economic point of view, the persons affected are the most valuable members of society, chiefly young adults between the ages of 20 and 40. The expense, in loss of time, medical attendance, etc., is at least $100 for each case, a total cost of $600,000 yearly from this one disease, to say nothing about the loss of life; and all because we are obliged to drink the sewage of half a dozen towns above us, and the drainings from graveyards and pigsties along the banks of the Schuylkill.

And while we are thus treated by the cities above us, we send our sewage to the towns below. Some strict measures must be put into practice, which will prevent this pollution of our drinking water.

The second important article of food, with which bacteriologists have busied themselves, is milk. A good milk must contain a certain amount of solids and fat, but it can be adulterated with far more harmful matters than water, and these other adulterations are not so easily detected.

A few hours after milking, ordinary milk has been found to contain 1,060,000 germs to the cubic centimeter. How did these get in?

If the udders of the cow are not kept clean, the first flow of milk will wash the dirt into the milking pan. If the man who milks the cow is uncleanly in his habits, using dirty hands in the operation, the milk receives this dirt. If the stall is the place for milking, and other animals are moving about, the dust raised falls into the open pail and contaminates the fluid; and, finally, in the transportation from the farmer to the collector, from the dealer to the customer, a hundred opportunities present themselves for the entrance of bacteria, which, when once in, thrive abundantly, the milk being a rich and suitable soil for their growth.

In the markets of Halle, Berlin and Leipsic, Ranke succeeded in finding, in the milk exposed for sale, considerable quantities of cow dung, which, of course, greatly increased the number of germs to the cubic centimeter—in one case up to 169,000,000.

Bolle, the milkman of Berlin, who sells 60,000 quarts of milk daily, has endeavored to make his large establishment conform to scientific requirements. He has a competent bacteriologist, who makes frequent examinations of the product. The milk is obtained from such dairies only as are under his inspection. Separate examinations are made of the different herds, so as to trace disease to its proper source. The collected milk is filtered each day through immense sieves of gravel, which have first been subjected to a high degree of heat in order to sterilize them. The milk is forced through from below upward, and collected in proper vessels. Four thousand quarts pass through such a filter in one hour. By this means the dirt is removed and with it about 50 per cent. of the bacteria present.

While this filtered milk keeps longer than the unfiltered, and is more readily sterilized, it is just as dangerous if disease germs were originally present, since, as was stated above, in connection with the filtration of water, the disease germs are just as likely to be among the 50 per cent. that pass through as to be among those that remain.

In order to render milk completely sterile, it must be subjected to such a degree of heat as will coagulate the casein and make the product undesirable in other ways. If, however, great care be exercised in the milking, and sterilization be carried on at once or shortly after, a very moderate degree of heat will be sufficient to make the milk entirely sterile.

One of the bacteria that is often found in milk has very resistant spores, and, therefore, if milk becomes contaminated by exposure to the dust and dirt of the air or stall, ordinary warming or heating, as is done when milk is pasteurized (so-called sterilized milk), will not suffice to destroy these spores.

Milk is often sold to us in bottles, and one would imagine that such a product was reasonably clean; but this bottling is done in a very careless way, often in the street by some ignorant delivery boy, while the street sweeper is raising clouds of dust, some of which lodges in the exposed milk.

In one dairy in Dresden, Germany, all the milk comes from stall fed or dry fed cows, experience having shown that such cows give a product that is less variable and contains fewer germs and sours less speedily than when they are fed on fresh grass. Great care is taken in the milking, and especial attention is paid to the cleanliness of the employes. After the milking the milk is placed in coolers, where it remains two hours at a temperature of 10° C. Then it is put into a centrifuge in order to separate the dirt that might accidentally have fallen in. It is now warmed up to 65° C. (pasteurized) and collected in half pint sterilized bottles, and the filled bottles again heated for one hour and three-quarters at 65° C. and quickly cooled. Such milk is reasonably sterile, and the method is the only one to be recommended.

Unless all these steps are followed, the milk cannot be considered sterile.

What danger is there in milk from tuberculous cows? This is a question which, just at present, is receiving considerable attention.

Tuberculosis is very frequent among cattle. In the slaughter houses of Berlin out of 142,000 head of cattle 21,000, or 15 per cent., were found to be tubercular. In all Prussia 10 per cent. of all the cattle slaughtered annually are found to be affected with this disease. Some veterinarians claim that 30 per cent. of all cows are infected, and that a herd cannot be found that is entirely free from the disease. From this one can readily see the importance of this question. In New York City 900,000 quarts of milk are consumed daily. Consumption is likewise a very common disease, causing from one-third to one-fourth of all the deaths among adults, and many, if not the greater number, of the diseases of children are tubercular in origin.

Is the cow an enemy to man? Are we warranted in accusing the milk of consumptive cows as being the cause of consumption in man? The last word has not yet been said on this subject. We can only give the opinions of authorities, the present beliefs gained from the knowledge at hand; and these are that if the udders of a cow are unaffected, if there is no local tuberculosis, no bacilli are to be found in the milk, the milk may be considered safe. Yet later investigations have shown that the toxic principles of bacteria find their way into the milk, that the milk of an animal rendered immune to diphtheria or tetanus has the same properties as the serum of the blood, and can protect other animals. If this is uncontroverted, then the milk of tuberculous or consumptive cows may have within it the products of the tubercle bacilli, and such milk may have the same effect upon the human organism as these products obtained artificially or from cultures outside of the body. The discussion on the benefits or ill effects of tuberculin has not yet been closed, and it is impossible to say, therefore, whether such milk, i. e., milk containing tuberculin, is positively harmless or dangerous.

In Paris all cows whose milk is offered for sale must be tested with tuberculin to prove their freedom from tuberculosis. Our own board of health has strongly advocated a similar test.

Tuberculin has been found reliable in the greater number of cases, i. e., if an animal showed signs of temperature rise after the injection of the tuberculin, the disease has always been found present; but the disease has been found when no rise has occurred, so that it is a positive test only. Tuberculosis is present whenever there is a rise of temperature, but it is not necessarily absent if no reaction occurs.

Because tuberculosis is so very frequent, because 2,700 deaths of adults between 15 and 45 occur every year in this city alone from this one disease, it behooves us to try every measure that holds out the slightest chance of success in reducing this awful mortality; and, therefore, if only as an expetiment, it would be worth the time and money to destroy every suspicious animal and thus prevent the sale of all milk save that obtained from perfectly sound cows. Any reduction in the death rate from this disease will be a step in advance, and our efforts should be directed to this end at all cost.

If the milk of consumptive cows is dangerous, then cheese and butter made from such milk is likewise dangerous, and the sale of such should be equally guarded against.

In Germany, butter has been made from sterilized milk by the addition of pure cultures of certain bacteria, which have the power of coagulating the milk. Such butter has a constant flavor, and does not deteriorate so quickly as butter produced in the ordinary way.

To summarize in regard to milk, we can say that (1) a careful inspection of the dairy; (2) a close examination of the cattle; and (3) cleanliness in the transportation and sale, must be rigorously enforced to safeguard the public health.

As regards meat, little has been said or done. Meat is rarely used in the raw state, and cooking generally renders ineffective the germs likely to be found present.

In the cities of Europe, careful inspection is practiced at the abattoirs and meat from diseased cattle is excluded or sold under restrictions. Meat shops are likewise kept very clean, and the meat is seldom exposed in filthy warehouses. In our own cities some of the meat offered for sale on the stands and in street shops is most unfit for food—some of it, indeed, in a state of putrefaction. Some cities have laws which make such meat liable to seizure, but these laws are seldom operative.

The advances in fermentation deserve attention, for though they are not, strictly speaking, connected with our subject, yet so closely are the yeasts related to bacteria, and so similar are the methods of cultivation, that any discoveries in the one field are sure to be of value in the other. Bacteria have always been a disturbing element in industrial fermentations and expensive methods have been resorted to to prevent the entrance of disease germs—disease here meaning impure or improper germs.

The yeasts were formerly considered as few in number—as alcohol producers and non-alcohol producers; no serious efforts were made to obtain pure cultures, but the mashes and brews were kept under such conditions that the foreign germs were prevented from growing or multiplying. Beer was stored in ice cellars, whisky was subjected to special temperatures, and other elaborate measures were used which can now be dispensed with if we start with pure cultures of yeasts at the beginning and avoid the entrance of impurities from air, water, etc.

In Denmark, Hansen (and from him a school has originated) pays great attention to the cultivation of pure yeasts. Brewers can obtain from the laboratories such pure cultures and thereby insure a definite alcoholic strength, a constant flavor and a product that will not deteriorate, even under varying conditions of temperature, etc.

By experimenting with different combinations of yeasts, various degrees of bitterness and different aromas can be developed.

Wines depend very largely for their bouquet, not so much upon the grape as upon the particular germ or germs used in the fermentation of the juice. Experimenters have obtained, with the same kind of grape, a half dozen different wines by using as many different yeasts. As the pigment yeasts produce various colors, so the yeasts used in fermentation give rise to various ethers, and these ethers give the wine its peculiar bouquet.

We should expect to obtain a Rhine wine from a New Jersey grape by using the yeasts which are common in the Rhine region or on the Rhine grape. Even out of apple must a good tasting wine has been produced by the use of particular cultures of yeast.

These researches have revolutionized German brewing, and the large breweries now have competent bacteriologists in their employ, who attend to the cultivation of their yeasts.

The spaces or holes peculiar to certain cheeses are due to the evolution of gases during the ripening process. These gases are produced by certain bacteria, and by using pure cultures of these gas-forming bacteria in the manufacture of cheese, these air spaces will always occur. The odor of cheese is likewise due to bacteria, and special flavors can thus be obtained at will by using the particular germs.

Bread made from pure yeast will be found to be more digestible, to be lighter and to possess a sweeter

flavor. Too little attention has been paid to this in baking. Mixtures of yeasts and bacteria are used, and the baking powder or the flour is blamed for poor results. Sour bread is usually due to a poor quality or impure kind of yeast. The soil out of which we obtain such important food stuffs has been studied bacterially and has been found to contain peculiar germs, which are all necessary to the growth of the plant. These are the so-called nitrogen-forming bacteria.

They convert the nitrates into nitrites, the oxidizers of organic material, more necessary to the well being of vegetable life than anything else. Instead of using tons of fertilizers, the agriculturist of the future will cover his fields with cultures of the nitrogen germs and obtain better results. We will even have special germs for special plants. The science of agriculture is yet in its infancy, if we may believe the promises held out to it by bacteriology. Even at present the agricultural colleges are equipping themselves with laboratories for bacteriological research.

Thus I have tried to show that the recent advances in this science are as nothing compared with what may yet be expected; that in these germs, microbes and bacteria, mankind has deadly foes and also important friends; that we must do all we can to rid ourselves of the former and make the latter our willing slaves.

THE SYNTHESIS OF PROTEIDS.*

SINCE Wöhler, in 1828, succeeded in making urea artificially from its elements, the strides that organic chemistry has made have been prodigious. Complex substances previously made only in the living laboratory of plants and animals are now manufactured in the test tubes and retorts of the chemist. The substances which are of most importance to vital processes, the carbohydrates and the proteids, are among the last to yield before this advance.

Fischer has, however, shown the way in which sugar may be made, but the synthesis of proteids, the most complex of all the compounds of carbon, is still not accomplished. There are, however, signs that this last conquest of organic chemistry cannot be far off, and when it has taken place we shall be nearer the settlement of many problems that now perplex the physiologist and the economist than we are at present.

The vexed question of the constitution of albumen will be set at rest; light will be thrown upon many physiological processes that are at present obscure, and we shall be on the road to determine with accuracy the components of protoplasm. Perhaps even in the distant future the manufacture of living material itself will not be such a hopeless task as it appears to be now. Economists, who paint terrible pictures of how in a few centuries the land will be unable to support the increased population of the globe, will be comforted if only it is shown them that chemists will be able to make the substances which up to now we have relied upon nature to provide us with.

I propose in the following paper to briefly sketch one or two of the principal attempts that have been made in the manufacture of albuminous from simpler substances.

The products of decomposition of a proteid are extremely numerous, and vary with the method adopted for their decomposition. Briefly, they fall into two groups, the fatty compounds generally containing an amidogen radical, and the aromatic compounds or derivatives of benzine. Our knowledge concerning these decompositions has been advanced by numerous chemists and physiologists, references to whose works will be found in a paper by Dr. Brodie in the September number of this journal. Among the names there mentioned it will be seen that Schützenberger's figures very largely, and to this observer belongs the credit of an attempt (one of the earliest conducted on scientific lines) to build up from the compounds he had obtained from albumen something like the original proteid he had broken up (1).

In order to effect the synthesis of proteid material, he considered it necessary to combine a molecule of a leucine (i. e., an amido fatty acid) with a molecule of a leuceine (an amido acid of the acrylic series), with elimination of water, and then to combine this complex group with one or more molecules of urea, and oxamide, also with elimination of water. The method he had adopted for the breaking up of proteids was boiling with alkalies. This led to hydration; so in any attempt at synthesis he recognized as a sine qua non the necessity of some method of dehydration.

The provisional formula he gives is the following:

$$H_2C_2O_4 + 2\ NH_3 + 3C_mH_{2m+1}NO_2 + 3C_nH_{2n-1}NO_2$$

with elimination of eight molecules of water. This would give $C_{q+2}H_{2q-8}N_8O_8$, and if q = 28, the percentage composition calculated from the formula agrees closely with that of albumen.

Accordingly, amido compounds, leucines ($C_mH_{2m+1}NO_2$) and leuceines ($C_nH_{2n-1}NO_2$), were mixed with about 10 per cent. of urea and finely powdered. The mixture was dried at 110° C., and intimately mixed with 1·5 times its weight of phosphoric anhydride, and heated in an oil bath. At 120° there is no change, but at 125° dehydration takes place very rapidly, and the mixture becomes pasty, but solidifies to a compact product without any darkening. This was dissolved in water, the solution mixed with excess of alcohol, and the pasty precipitate so produced washed with alcohol and redissolved in water. Phosphoric acid was removed by means of baryta, and the filtered liquid when concentrated on a water bath yielded an amorphous product soluble in water, but was precipitated as a curdy mass on the addition of alcohol.

Aqueous solutions of this product are precipitable by most of the other precipitants of proteids, namely: tannin, picric acid, mercuric chloride, Millon's reagent, potassium diiodide, mercuric potassium iodide, phosphotungstic acid in presence of hydrochloric acid, phosphomolybdic acid and lead acetate and basic lead acetate. Potassium ferrocyanide, however, gives no precipitate in presence of acetic acid. With caustic potash and copper sulphate a rose red coloration is formed. Heated with nitric acid, the product becomes orange on adding ammonia, and when heated decomposes suddenly, leaving a bulky mass of carbon. Its behavior in this respect is similar to that of gelatin. When heated on platinum, the compound carbonizes and swells up, giving the characteristic odor of burning nitrogenous animal matter.

We thus see that although Schützenberger succeeded in obtaining a substance very like albumen, yet the experiments are hardly conclusive, because some of the characteristic properties of albumen are wanting, and the color tests for proteid are given by many of the decomposition products of albuminous matter. His partial success will, however, point the way for future attempts, and so far as it goes is in favor of his theory of proteid constitution.

Some years previous to this, Grimaux (2) obtained by somewhat simpler processes substances which even more resembled proteids than Schützenberger's. He was especially interested in colloidal substances, inorganic and organic, but the three that he made which bear on the present question were the following:

(A) Colloide amidobenzoique. This is made by heating to 125° C. meta-amidobenzoic acid in sealed tubes with one and a half times its weight of phosphorus pentachloride for ninety minutes. The product, which is a white, friable powder, is washed repeatedly with boiling water to remove all phosphoric acid. The remaining substance is supposed by Grimaux to be an intramolecular anhydride formed by the union of several molecules of meta-amidobenzoic acid with the elimination of water. When ammonia is added it dissolves slowly in the cold, but rapidly on heating. The solution obtained should be evaporated in vacuo at a low temperature. The resulting solid is a transparent jelly which dries into translucent, yellowish plates, which in their physical properties resemble dried serum albumen.

(B) This colloid is similarly prepared, except that the temperature in the sealed tubes is allowed to rise to 135° C.

(C) Colloide aspartique is prepared by the action of a current of gaseous ammonia heated to 170° C., on solid aspartic anhydride. The product is washed with water, and after evaporation in vacuo yields a substance similar in appearance to the colloid (A).

It will be seen from this that the obtaining of albumen by these methods was hardly to be expected, but rather one would get a product which would be, as it were, a skeleton of a proteid; in all cases heavy molecules were formed; in all cases the result was a colloid substance exhibiting, as we shall see directly, many of the properties hitherto deemed diagnostic of proteids, and in the case of the two first colloids there was present not only the amidogen, but also the aromatic radical.

The resemblance between the proteids and these synthesized colloids is however remarkably close, and Dr. J. W. Pickering, who has been instrumental in bringing Grimaux's work prominently before English physiologists, has confirmed most of his results, and also discovered certain other similarities which were not noted by Grimaux. I take the following brief resumé of the chief of these similarities from Pickering's papers (3).

1. All give the xanthoproteic reaction.

2. With copper sulphate and caustic potash, A gives a blue violet; B, nil; C, a typical violet coloration.

3. Their solutions do not coagulate on heating in the absence of salt; if, however, a trace of a soluble barium, strontium or calcium salt is present, opalescence occurs at 56° and coagulation at 75° C.

4. The colloids are removed from solution (rising to the surface of the fluid) by saturation with magnesium sulphate, ammonium sulphate or sodium chloride. Here they especially resemble the class of proteids called globulins.

5. Another resemblance to globulins is seen in their behavior to a stream of carbonic anhydride, which in the presence of salts causes precipitation. The passage of a current of air through the mixture redissolves the precipitate.

6. The colloid B is not digested by pepsin-hydrochloric acid; A is slightly digestible; but C is easily digested, and then the solution gives the typical peptone color, pink, on the addition of copper sulphate and caustic potash.

7. Each of the colloids when intravenously injected into animals (rabbits, cats, dogs, rats, guinea pigs) causes extensive intravascular coagulation. In a typical experiment death is due to respiratory failure, and 5 to 20 c. c. of a 1·5 per cent. solution is usually fatal. The other symptoms noticed are pronounced exophthalmos and dilatation of the pupil; in dogs there is often hyperpnœa immediately before death.

This last property of the proteid-like colloids is the most remarkable of the series, and its discovery is entirely due to Dr. Pickering. The resemblance to the action of the nucleo-proteids is most marked, and extends even to minor points, e. g., neither cause intravascular clotting in the blood of albino rabbits; and in dogs very minute doses indeed cause a slowing of the rate of coagulation; but for these and other details the reader must consult the original papers.

I need hardly say that the result was an unexpected one, and it by no means lessens the difficulties surrounding the coagulation question. So far as was previously known, only nucleo-proteids produced intravenous clotting, with the single exception of snake poison. Snake poison, however, produces extensive disintegration of the vascular wall, and so it was considered that this was the source of the nucleo-proteid. The artificial colloids produce on the other hand little or no disintegration of leucocytes, and no injury to the capillary walls, so that the same explanation will not hold here.

If nucleo-proteids and these colloids both produce the same effect in the same way, one is driven to the conclusion that their physiological activity is connected in the first place with the heaviness of their molecules and in the second with the presence of some radical common to both.

The colloid condition will not entirely explain the action, since many colloids do not act in the same way; the active radical is certainly not one which contains phosphorus, since all the colloids are free from that element; it may possibly be the amido-fatty radical in a high state of condensation which is responsible for the clotting produced.

It is these two principal sets of researches that I wished to bring before the readers of Science Progress, because, although both fall short of their ultimate object, the synthesis of proteid, yet they show the way to be followed in the future, and, moreover, they exhibit in themselves certain points of interest, of which the one treated last, the physiological action of Grimaux's colloids, is by no means the least.

I have not alluded in the foregoing paper to Lilienfeld's work on the synthesis of peptone. He has only brought the matter forward in a preliminary notice, and for important researches of this kind, one requires full details before their value can be estimated.

BIBLIOGRAPHY.

(1) Schützenberger. Compt. Rend., cvi, p. 1407. Ibid., cxii, p. 198.

(2) Grimaux. Compt. Rend., xciii, 771; xcvii, 231, 1336, 1434, 1485, 1540, 1578. La Revue Scientifique, April 18, 1886; this gives a summary of the others.

(3) Pickering, J. W. Journal of Physiology, xiv, 347; xviii, 54. Pickering and Halliburton, Journal of Physiology, xviii, 285.

W. D. HALLIBURTON.

* From Science Progress.

MODERN SURGERY OF THE EYE.

By WILLIAM OLIVER MOORE, M.D.

OF Nature's minute wonders, the human eye is the paragon. It is the window of the soul, and gives expression to the whole man; for Emerson says: "Vain and forgotten are all the fine offers and offices of hospitality, if there is no holiday in the eye." And Shakespeare makes Romeo in Capulet's garden say:

> "She speaks, yet she says nothing, what of that?
> Her eye discourses; I will answer it."

Thus we see that the eye is not only important for the actual visual purposes of life, but also for the expression machinery incident to social existence. In order to describe the surgical treatment of the eye, a short description of the organ will be necessary.

Most readers are probably aware that the eye of the most highly organized animals and of man is a camera obscura, or dark chamber, similar in many respects to the instrument with which the photographer accomplishes his very beautiful process of making pictures by the power of light. The eyeball is spherical in shape and, generally speaking, about one inch in diameter; the outer investment of the eyeball consists of a tough white membrane of much strength, which is termed the sclerotic coat; it is opaque and impervious to light except for a short space in front, where it is transformed into a kind of bow window of transparent, hornlike substance called the cornea. Through this window the pupil and iris can be seen. The iris is an adjustable curtain of interlaced muscular fibers, arranged immediately behind the cornea in such a way that it can be more or less drawn, according to the need of diminishing or increasing the admission of light. The pupil is simply a hole in this muscular curtain. Immediately behind the pupil is fixed a double convex lens of transparent substance, having the power to form a picture behind it, in the same manner as the lens on the photographer's camera. The picture formed falls on the nervous expansion called the retina, and, through the agency of its connection with the brain, is capable of feeling the image in all its diversity of color and luminous intensity.

The eye is preserved in the convenient form of a sphere by the simple device of having its interior filled with liquid, which prevents the otherwise flexible coats from puckering up into an irregular mass. There are two quite distinct chambers in which the liquid is distributed—one in front of and the other behind the crystalline lens; the liquid in front is called the aqueous humor, and is little more than a solution of common salt; the portion behind more nearly resembles the white of egg, and looks like glass, and is, therefore, called the vitreous humor.

The optic nerve is the great channel of visual impressions from the eye to the brain, where it has its origin. It is composed of very fine nerve threads: at least 250,000 of these are packed closely together in each optic nerve. The eyeball is held in the orbit by means of muscles, there being six to each eye. This beautiful window is screened by the eyelids and lubricated by the tear apparatus, the excess of moisture being carried into the nose by an ingenious drainage system. Such, in barest outline, are the mechanism and the optical arrangements upon which the function of vision depends.

Operations upon the eye are made for the relief of pain, to restore vision, and for cosmetic effect.

Since the introduction of the anesthetic cocaine, in 1884, a revolution has taken place in eye surgery; operations formerly performed under the influence of a general anesthetic like ether, or done without it, the patient suffering great pain, are to-day painlessly performed by the simple dropping between the eyelids of a watery solution of cocaine. The discovery and application of this drug to ocular surgery is one of the events of the century. It has simplified procedures, rendered the patient comfortable, and increased the percentage of success. Rarely, indeed, do we now use ether as an anesthetic in eye surgery where formerly it was of daily occurrence. One cannot extol too highly the virtues of cocaine in this branch of surgery. It has so simplified all surgery of the eye that patients are inclined to belittle the importance of some of the gravest operations. As can be readily seen, all operations on the eye must be very delicate and done with great precision, as the organ is so small and its parts so compactly placed.

Modern surgical art has made the operation for the relief of cataract one of the simplest and most really attractive of the operations made on this delicate organ, for the reason that usually there is no blood showing, and the steps of the operation can all be plainly seen. There is nothing revolting in the surgical procedure, and, as there is absolutely no pain, friends can look on with composure.

I have frequently had ladies witness the operation and say afterward that they had been highly instructed and interested. The surgeon always begins the operation of extraction of cataract in old people with pleasure, for, in properly selected cases, he feels sure in ninety-nine per cent. of making a perfect result. What can be more gratifying than to make the blind see? The patient, blind with cataract, lies down, having only perception of light, and by the operation of a few seconds' length, can immediately see and notice his surroundings. The operation is called extraction,

because the cataract is really removed from the interior of the eyeball, the same as a pea from the peapod. It is a common mistake among the laity that a cataract is "taken off" the eye, as if it was on the outside; a cataract is simply the natural, clear, crystalline lens (which belongs in all eyes) becoming opaque, and closing up the window of the eye. The operator removes the opaque obstruction and the patient sees. In former years the cataract was thrown from its upright position behind the pupil downward, and left in the eye. This operation was called couching; it was abandoned, as it produced serious inflammation.

In extracting the lens, or cataract, we first, after properly cleansing the parts with aseptic fluids, and applying the cocaine solution, fix the lids open by means of a spring, then hold the eyeball firmly with a delicate pair of forceps in one hand, and in the other take a beautifully delicate and very sharp knife, about one and one-quarter inches long and only one-eighth of an inch in width; this is thrust, point forward, into the eye, at the junction of the white with the clear cornea; the knife then passes behind the cornea and in front of the iris the width of the front of the eye, and the point of the knife is made to pass out, so that in this position the knife has transfixed the eyeball, and can be clearly seen by a to and fro motion of the hand the knife is made to complete the cut, which is fully half an inch in length, but so nicely done as to fall in the line of the upper junction of the white with the clear cornea. This, of course, takes much less time to do than to describe. Next a small piece of the iris, or colored curtain of the eye, is removed upward by forceps, leaving a keyhole-shaped pupil; then a delicate instrument is introduced, and the front part of the membrane that holds the cataract is lacerated by making a T-shaped incision: this allows the cataract to come forward. All being in readiness now, the lens or cataract is extracted by making gentle pressure by means of a spoon-shaped instrument upon the outside of the eyeball below the center; this makes the wound made above to bulge, and, by the continued pressure, the cataract is extruded from within the eye. The parts are gently bathed with warm boracic acid solution, and a bandage applied; both eyes are covered for a week, and then smoked glasses are worn for two or more weeks, when glasses for reading and distance are given, and the patient has vision as good as ever. To-day I gave glasses to a patient upon whom this operation had been performed two weeks ago, and handed him the Bible, and he read the third verse of the first chapter of Genesis: "And God said, Let there be light, and there was light." "How appropriate," he remarked: "for this is the first time in five years I have been able to read." As we are so dependent without correct sight, nothing appeals so to the patient as this restoration of vision.

Soft cataract, or that form coming in the young, is treated in an entirely different way; and the operation is known as needling, because a delicate needle is thrust through the cornea and then through the capsule of the lens directly into the opaque mass. The consistency of a soft cataract is similar to boiled starch. The rent made in the envelope of the cataract allows of the entrance of the fluids of the eyeball, thus causing the cataract to swell and absorption to take place. After several such operations, an interval of several weeks elapsing, the whole cataract will be carried away by absorption, leaving a clear pupil through which to see. Children born with cataract have them treated in this manner and may be operated upon as early as three months old.

Artificial pupil, or iridectomy, is another of the interesting operations done upon the eye. In any affection of the eye where the pupil is closed, or where an opacity is situated on the front of the eye over the pupil, an artificial pupil is necessary. It simply consists in removing a portion of the colored curtain and leaving a pupil in the direction of the incision made; for in order to remove the portion of iris a wound has to be made in the cornea, and this is usually done with a trowel-shaped knife, which is pushed in at the junction of the white with the cornea; and then a pair of delicate forceps are introduced into the anterior chamber, and the iris grasped, pulled out and cut off by fine scissors, making thus a new pupil. This operation has a wide range of application and is the one resorted to successfully for the cure of that dread disease, glaucoma.

Foreign bodies that enter the cavity of the eye are a source of great danger to sight, and have to be extracted as quickly as possible; where the substance is iron or steel we introduce an electro-magnet and extract it by attraction; when some other substance, it is removed by forceps by enlarging the wound of entry. For foreign bodies on the outside of the eye, such as particles of coal, scales of iron and the like, where, after cocaine has been used, they cannot be wiped away by cotton on a small stick, we must resort to a fine steel instrument and pick it off. It is a good thing when by accident a particle enters the eye to refrain from rubbing or in any way touching the eye; the gush of tears will usually flush the eye and float out the offending intruder; but if vigorous rubbing is indulged in, the particle is pretty sure to become fixed and need special assistance for its removal.

Tattooing of a white scar on the front of the eye is one of the novel things done, and is useful, not only in improving the appearance, but also the vision. The operation is performed in the same way as upon the skin with India ink and the use of needles.

Another odd operation is the transplanting of the conjunctiva of the rabbit on the human eye, to supply tissue destroyed as the result of severe burns; this operation is successfully performed. It is a very delicate operation and requires much patience. The whole rabbit's eyeball has been transplanted and placed in the human orbit, and adhesions have formed between the living and the transplanted tissue. Of course, the object in this operation is for cosmetic rather than visual effect. Thus far this operation is in an experimental stage, and will probably never be of practical value.

Besides these operations mentioned above on the globe of the eye, we have to correct deformities of the eyelids and remove growths therefrom.

Cross eyes or deviations of the eyes from the median line are corrected by the operation of tenotomy, which means the cutting of the muscle having the greatest power.

Tenotomy may be performed on any of the external muscles of the eye, but is most commonly done on the internal straight muscle for the correction of convergent squint and next most frequently on the external straight muscle for outward turning of the eyeball. The operation is simple and should be resorted to more frequently, as it is not only a deformity, but causes failure of sight in the squinting eye.

Parents do a great injury to their children by not having the tenotomy done early; as soon as four years of age will answer. The longer the strabismus or squint lasts the more difficult is it to correct. We have seen many cases of deformity due to the neglect of the parents. The operation can be done with scarcely any pain by the use of cocaine; only in the very young should ether be used. The lids being held open by a spring and the eyeball fixed, the operator grasps the covering of the eye over the site of the muscle to be cut, and then, making a small buttonhole in it, a small blunt hook is inserted through it and passed under the muscle; this is then drawn upward and the insertion of the muscle to the globe severed. The opposite muscle pulls the eye in its direction and the eye becomes straight. The wound is so small and carefully made that no scar or mark is usually seen; the popular idea that the eye is "laid out on the cheek" and operated on, is, of course, not true; probably the spring-like instrument used to keep the eyelids open has given this impression, as the eyeball looks very prominent when it is in position.

Enucleation of the eye or the entire removal of the organ is one of the most distressing operations we have to perform, for afterward there is no hope of vision. The popular idea that the eyeball can be removed and then returned to its former position is, of course, absurd, and no thoughtful person would for a moment think restoration possible. After the removal of the eyeball the defect is corrected by the insertion of an artificial eye, which can be so artistically made and arranged that it is very difficult to detect.

Operations are made on the tear ducts to relieve conditions of watery eye by probing the canals and in some instances by the incision of one or other of them, thus giving free drainage to the nose.

To sum up, the surgery of the eye is difficult only in its minute detail and requires special technic. The antiseptic precautions used in other surgical procedures are practiced here, and the only anesthetic usually required is the preparation of cocaine already mentioned.

From the above facts it behooves us so to treat our eyes that we shall not be "presented with a universal blank of Nature's works," or "wisdom at one entrance quite shut out."

New York City.

THE TREATMENT OF FEVERS WITHOUT FOOD, ANTIPYRETICS OR ALCOHOL—WITH RECORDS OF VARIOUS CASES.

By A. MONAE LESSER, M.D., New York, Surgeon for Abdominal Diseases to the Red Cross Hospital; Member of the Academy of Medicine, Etc.

IN 1886 I began to treat all fevers, medical and surgical, without food, antipyretics, or alcohol. Instead I used large quantities of water and a few simple remedies which I shall describe in detail later on. Ab initio, my results were far better than they had been when I still adhered to the older and yet recognized plan of feeding and stimulation.

There is scarcely anything new in my method, which, in a primitive way, was practiced by the ancients. Thus I do not come as the herald of an entirely new and startling discovery. Researches into the physiology and pathology of the subject have taught me that in all forms of fever, medical or surgical, the exanthematous, typhoid, or the traumato-septic varieties, we invariably find changes in the gastro-intestinal mucous membranes. In some instances these changes are anatomical, while in the acute and more simple varieties they are chemico-mechanical in character; yet in both the physiological function of the membranes is changed and impaired.

It may not be out of place in this connection, before touching the question of treatment, to refer briefly to the observations of distinguished physiologists who have enlightened us on this point. Beginning with the saliva, Uffelmann * says: "The secretion of the saliva becomes diminished by fever, and in high temperature no saliva is secreted at all. In the lower ranges of temperature—he evidently refers to acute conditions—the saliva—normally alkaline—becomes turbid, thick, and sour, and with the increase of the fever the power of the saliva to convert starch into diastase is materially diminished."

Passing over the function of the muscular action of the stomach indigestion, Beaumont † records, as the result of his experiments, that in cases of fever the gastric juice is only sparsely secreted, and the mucous membrane is soft and irritable.

Hoppe-Seyler ‡ examined the gastric juice of a patient with typhoid fever and found no free hydrochloric acid. This was also the case in other instances where the gastric juice was taken from subjects in whom there was an elevation of temperature. He found it utterly inadequate to carry on digestion artificially even after the addition of hydrochloric acid. The same author expresses the opinion that under these conditions the gastric juice has a tendency to become neutral in reaction, and stomach digestion can no longer go on. Instead, we get lactic and butyric acid fermentation and the formation of gases, and with them we find the sarcinæ ventriculæ and other micro-organisms, first observed and described by Goodsir § and Manassein, ‖ who also proved that the observations of Hoppe-Seyler were correct.

Gluzinski, of Cracow, records that he found neither hydrochloric acid nor peptones in the gastric juice during the entire stages of typhoid fever.

Explaining the cause of dyspepsia in fever, Landois ¶ says: "The secretion of a peptone-forming fluid is arrested when the fever begins very violently, when there is great weakness, or when high temperature long continues." This author also emphasizes the fact that the gastric juice is diminished in all cases of fever.

It is well known that in acute febrile conditions, notwithstanding that the bile is diminished in quantity, it is more watery and poorer in specific ingredients. That similar changes occur in the pancreatic and intestinal juices is shown by Stolnikow,* who says: "On high ranges of temperature the pancreatic juice is diminished. Examination shows fat in the form of drops and bundles of crystals which may be isolated from the stools." He also found that fluids are quickly absorbed in persons with elevated temperature, whereas the absorption of peptones is much diminished. This is also established by Beaumont and others.

In the face of these facts it became a question to me whether it was justifiable to introduce into the animal economy food that cannot be disposed of and utilized, and that can at best only act as a foreign body, undergo putrefaction, and gave rise to ptomaines, that in themselves must tend to elevate temperature.

My experiments and observations at the bedside have in every way borne out my reasoning. At the meeting of the Academy of Medicine, last March, in discussing a paper on the treatment of typhoid fever, † I said: "I have in times gone by employed the milk diet in typhoid fever. One patient refused it and I gave her only water, and she was able to live upon it for twenty-one days.

"From that time on I began to investigate how much or how little food my typhoid fever cases needed. While I do not yet presume to generally recommend the method so new, still what little I have to say upon the subject of allowing typhoid fever patients no nourishment whatever, save water, is based upon my results in eight cases, all of which made a good recovery without relapses, and in which from five to fourteen days I permitted the patients to take nothing but water ad libitum, only administering diluted milk at the expiration of that time, or rather when the patient expressed a desire for some nourishment. In these cases I had no occasion to use alcohol or antipyretics, although the range of temperature was such that according to the recognized methods of treating typhoid fever I would have been justified in administering them. I have since adopted this plan in all fevers in which the temperature is over 102° F."

My method of procedure is as follows: First of all the bowels are flushed well with a high enema of lukewarm saline water. If the tongue of the patient is pale, covered with a white or grayish coating, I prescribe two hourly doses of a teaspoonful of a solution of sodium sulphite, 4·00 to 60·00 of water, while, if the tongue has a red base, clean, or is covered with a dark brown or grayish coating, I administer dil. muriatic acid 1·00 to 100·00 water in the same doses at the same intervals.

Should the stomach be in a highly irritable condition, nothing has given me greater satisfaction than a two hourly teaspoonful dose of a mixture of carbolic acid, 1·00 suspended in a solution made of 30·00 of mucilage to 125·00 of peppermint water. If the disease be a painful one or involve serous membranes, doses of 0·6 sodium salicylate in 100·00 of water are repeated every two hours until all pain has subsided; I have found this remedy to be most serviceable and far preferable to the opiates.

There are occasions in which the stomach may be found to contain a large quantity of food. In such instances I freely lavage, or if the case is suitable, begin with an emetic before administering any other drug. I have seen cases watched by careful nurses where large quantities of undigested milk coagula were returned in the lavage. I recall a case in which washing revealed an unusually large quantity of milk coagula taken nineteen hours before, and another which returned a partly putrefied oyster which the patient had swallowed whole twenty-three hours previous.

It is from experiences like these that I have made it an absolute rule to empty the stomach in cases where I suspect the presence of food. The results which have followed this apparently heroic commencement of treatment were such that I did not find it necessary to continue medication in large doses for any length of time. The pulse improves and very soon the patient begins to be more comfortable, the headache, malaise, and other annoying symptoms gradually diminishing in severity.

Be it understood, however, that I do not claim to lessen the duration of any disease of certain course.

I also have the patient sponged frequently with water three degrees lower than the prevailing temperature. If this be above 104° F., under no circumstances do I permit any nourishment to be taken. However, when the pyrexia is lower than this, and the patient craves for something, I give clear broths, containing, as I believe, the salts of the meat only; rice and barley water with a pinch of salt, but never do I attempt to induce the patient to partake of food. Simultaneous with the lowering of the temperature I have observed that the patients become desirous for nourishment, while on the other hand their aversion to it increases as the temperature rises.

I now continue with whatever medication is indicated. I have altogether discarded the internal administration of antipyretics, as I think they diminish the tone of the heart, thereby deluding us into the belief that our patient has improved simply because the temperature is so many degrees lower, when in reality his vital powers are much weakened and he has less resistance to combat his disease. This fact Cantani ‡ has so beautifully made clear to us. The bacillus also can thrive and propagate much better in lower than in higher temperature.

As to medication, I employ aconite in 0·6 to 250·00 of water, of which I gave teaspoonful doses every hour, not to diminish the temperature or lessen the frequency of the pulse, for aconite in these doses, in my opinion, acts as a heart tonic, in that it relieves the pressure upon the capillaries and so equalizes the circulation.

I administer aconite at the onset of the disease if the pulse is frequent and weak, the extremities cold, while

* Munk and Uffelmann: Die Ernahrung des gesunden und kranken Menschen. Berlin, 1887.

† Beaumont, Leipsic, 1834.

‡ Die Verdaung und Resorption der Nahrstoffe, p. 241. Berlin, 1878.

§ Biological Memoir. Edinburgh, 1868.

‖ Archiv fur path. Anat., Band 55, 1872.

¶ Physiologie des Menschen, p. 351. Leipsic, 1885.

* Pfluger: Archiv d. Physiologie.

† Medical Record, May 26, 1894, p. 671.

‡ Transactions of the International Medical Congress, Berlin, 1890, vol. i.

I prefer veratrum viride in the same doses and same intervals as the aconite when the pulse is rapid and full.

It is astonishing to see how rapidly the small doses of these two drugs act. I have not yet had occasion to have recourse to alcohol in any of my cases. If heart tonics are needed, I rely upon caffein, provided the heart sounds are weak, and upon nitroglycerin when its beats are rapid or intermittent.

The dose of caffein I employ, repeated as required, is 0·15, and of nitroglycerin 0·0003 every three, four, or five hours, as the case may require. Strychnine in 0·0005 doses I give in addition to either of these drugs, principally when I use nitroglycerin, always, however, giving these drugs uncombined, and most frequently hypodermatically.

In all these cases water with a trace of sodium chloride, not sufficient to affect its taste, is given ad libitum. The quantity taken in twelve hours varies from 1,000·00 to 1,300·00. It is remarkable to observe how readily it is retained by the most sensitive stomach, provided that the organ is free from other food. It is readily absorbed, restoring to the blood the fluids which the intense febrile condition robs from it, and thereby keeping the cells in the different tissues in a mild but constant state of activity; it increases the action of the liver, as also the action of the kidneys, lessening their work by secreting bile and urine of lower specific gravity, and holding the specific elements in higher solution.

Of its effect on the intestinal tract it may be said that the juices, although changed in character, become less irritating in their local action, when thus highly diluted, and excessive diarrhœa therefore does not become a complication of the disease—on the contrary, I have found it has a tendency to enhance easy stools from the very beginning.

Thus, in every instance I flush the bowels daily, and have often observed that its returns contained quantities of undigested matter, including coagulated milk, incased in intestinal secretions, even eighteen days after the patient had partaken of any food.

This method of treatment has given me abundant proof of its efficacy, and it is reasonable to assume that when nothing offensive is carried through the digestive tract, nothing deleterious can be carried into the blood and nothing additional brought into the system to support the micro-organism of the disease; while at the same time a constant washing of every portion of the less affected parts of the body is continually going on, until the hungry state of the tissues requires nourishment, as is evidenced by the patient's demand for food.

That this will ease and lessen the danger of febrile disease more than the feeding or stuffing methods, I beg to illustrate in a case of croup, treated in February of last year, and which was seen in daily consultation by Dr. O'Dwyer.

When first I suggested the advisability of administering no food, save water, Dr. O'Dwyer dissented, and for two days we gave milk at regular intervals. We observed that within half an hour after the administration of the milk, the patient was seized with paroxysms that were associated with a rise of temperature and general indisposition. After forty-eight hours of this state of affairs, Dr. O'Dwyer agreed to continue the treatment without nourishment, on water alone. We pursued this course for three days, during which time the temperature gradually dropped, and the paroxysms became less frequent and the patient's general condition materially improved, until at the end of the third day the temperature had fallen to 100° F., and the favorable outcome of the case was assured. We then resorted to milk feeding with well diluted milk, and in one week our case was fully recovered without any sequelæ. The usual remedies, including fumigation, were used, but intubation was not resorted to.

Knowing, as we do, that it requires a certain time to digest milk, even with normal secretions, and considering, as Bouchard * has shown, that milk increases the temperature when administered in any febrile state, and especially in view of the fact that peptones cannot be absorbed under such conditions, does it not speak loudly against the giving of nourishment, as is so frequently practiced, with digestive secretions abnormal, deficient, or altogether absent?

I have observed that, contrary to what we might expect, patients kept on water alone lose less weight than those fed upon a mild and easily digested diet, which leads me to believe that water maintains the patient's vitality better than food—that is a food in the truest sense of the term.

It is almost obvious that where the intestinal glands are affected, and the stomach secretions changed on account of an elevated temperature, and with blood containing excrementitious matter, we cannot hope for the utilization of anything that has been taken in for absorption.

Since first I made known my views upon this manner of treating fevers, I find that others have also made clinical observations in line with mine. Among the papers recently published, that will repay perusal, are those of Dr. Licorish,† Dr. Page, of Boston,‡ and Dr. A. P. Henry.§

I trust that the method of treating fevers as I have described it above from careful notes from my case book will prove worthy of furthur investigation, and I hope my colleagues, especially those who are fortunate enough to possess hospital facilities, will give it honest consideration, and report their results at an early day.

72 East Sixty-first Street. —Medical Record.

THE PHYSIOLOGICAL ACTION OF ACETYLENE.

By Dr. W. H. BIRCHMORE.

THE introduction of ethine as a commercial article and the proposition to use it as a means of lighting for domestic and other plants, especially for portable lamps, brings into prominence its possible influence on the human subject, and on animal life in general. The chemistry books have for years set forth that ethine had poisonous influence on life, but the extent and kind of influence exerted has never been discussed at length or in detail by any person in connection with its commercial use. Indeed, beyond the statements in the books referred to, the fact of its physiological action has hardly been questioned at all.

During the month of May last past it was my good fortune to be so situated that a daily study of some of its effects was possible and although the narrative of the observations would have an interest of their own in connection with the action of gases on the blood, they are not in order here. Certain general conclusions were possible, and as they have a relation to the commercial use of the gas, they are given for what they are worth.

"The amount of the gas that can be diffused in the air of a room without perception by the senses."

It is a well known fact that under pressure the amount of a gas that can be forced through water by the process of diffusion is a function of the pressure and also of a coefficient that varies with each gas investigated. In the case in question it is very high. The published experiments of various authorities place the amount that may be dissolved in water at 60° F. as more or less exactly the bulk of the water; and it is a curious fact that this holds true of the watery vapor evaporated from a pan holding the water in which the gas has been dissolved. Carefully arranged experiments extended over a number of days showed that if the gas was under a pressure greater than that of the atmosphere in one part of the pan, the rate of loss was decidedly greater than the rate of evaporation of the water, in the other part; consequently, while the loss from the pan under the pressure of the atmosphere was the same as the decrease in the water from evaporation, under the pressure that might arise in a gas meter, the passage by the "transfer from next to nearest molecule" under a pressure of two inches of water could reach to twice this under the conditions of ordinary use. To decide this question in another way, an absorption apparatus was run from noon on Saturday to noon on Monday in the room in which was standing a holder that contained the gas under a pressure of two water inches. The space about the holder was in effect a quarter of a square foot. There was some ethine in the air of the room when the experiment was commenced, as shown by the formation of the copper compound by passing the air through the test solution, but as the air in the room was known by measure to be changed once in every hour, evidently if there should be shown to be a continued presence of the gas, it must come by diffusion from the holder. An apparatus was rigged that would pump air slowly through the test solution during the time of the experiment, and during the 48 hours under examination the amount of gas present was sensibly the same as at other times. This shows that the amount present came from the holder by continuous diffusion. This amount, which was about 10 c. cm. per hour for each square foot of exposed surface under a pressure of 2 inches of water, was quite imperceptible to the sense of smell.

"The amount of gas required to produce headache."

Twice in the course of my studies the opportunity occurred to measure the amount that diffused in the air of the room would produce distinct headache in the course of a short time, and it was found to be rather unexpectedly large as compared with the product of the imperfect combustion of the ordinary illuminating gases. As stated, the air in the room was known to be changed once in an hour. The cubic contents of the room was about 5,000 feet if a proper allowance is made for the space occupied by properties. The amount of gas diffused was $2\frac{1}{2}$ cubic feet, or one in 10,000. Within 20 minutes a decided headache was noticed, with a sense of dizziness, that was a sufficient warning to get into fresh air. The second time the experiment was made of remaining until the sight was slightly affected; this proved very foolish, for in the course of an hour after leaving the room respiratory difficulty appeared, and in the course of a few hours nausea, and a prostration and sense of the impossibility of exertion that forced me to remain in bed all the next day. The effects were not those of sleep, but the exact counterparts of the subjective effects of the ether narcosis, hallucination and all. Three days afterward the heart respiration ratio was so sensitive that an attempt to walk rapidly across the Brooklyn Bridge produced such a feeling of exhaustion as to compel rest.

The important fact in this connection is that a man well acquainted with the smell of acetylene was twice in the room in the course of this experiment, and on question afterward said that he did not notice anything peculiar about it, and certainly had not noticed the "smell of the acetylene." It is possible that the very familiarity with this smell may have blunted his perception, but at the same time it may be urged that he would have been doubly sensitive knowing the danger involved in breathing it. It is therefore safe to say that as much as one part in ten thousand may be diffused in the air of a room without being detected by the sense of smell in some persons, and that this amount can produce dangerous effects.

"Can this dose of 1 in 10,000 be considered fatal, and if so, how long a time is required to produce this effect?"

Up to date there is no record of any attempt at "Suicide with Acetylene for the Sake of Science," but an experiment on a guinea pig gave the following:

Alarmed at my own experience, it seemed a good thing to know if a reasonable limit could be set to this sort of thing; so a large healthy guinea pig was confined in a tight box, containing 216 cubic feet. Experiment showed that confinement in this box under ordinary conditions for a period of 48 hours had no effect on his health, appetite, or spirits, although the air must have been much deprived of its oxygen, by the measure it sank below the proper respiratory limit for human beings; therefore I judged that any error that might get in would be on the safe side. At ten o'clock in the forenoon I drew out 35 cubic inches of air, and substituted ethine; in about ten minutes my prisoner was evidently uneasy, and in half an hour was hid away under the straw, the usual habit of guinea pigs when in distress. They do not run about as do some animals, and when at four o'clock I opened the box my pig was dead and his blood had lost the power of absorbing oxygen almost as if killed by cyanogen. As the guinea pig is a rather hardy little beast under this sort of treatment usually, it seems certain that a man would or could be fatally injured by breathing a mixture of 1 in 10,000 of ethine for 6 hours.—Electrical Engineer.

* Auto-intoxication in Disease, p. 217. Philadelphia, 1894.

† Medical Record, June 2, 1894, p. 706.

‡ Ibid., February 24, 1894, p. 230.

§ Ibid., May 25, 1895, p. 648.

TABLE OF CONTENTS.